Environmental Impact Analysis Process

Draft
Environmental Assessment
for
U.S. Air Force
atmospheric interceptor technology PROGRAM

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DEPARTMENT OF THE AIR FORCE
Material Command
Headquarters, Space and Missile Systems Center

DRAFT
FINDING OF NO SIGNIFICANT IMPACT (FONSI)
U.S. Air Force *atmospheric interceptor technology* Program

Pursuant to the National Environmental Policy Act (NEPA), the President's Council of Environmental Quality (CEQ) regulations implementing the Act (40 Code of Federal Regulations 1500-1508), Department of Defense (DoD) Regulation 5000.2 and Air Force Instruction (AFI) 32-7061, which implements these regulations through the Environmental Impact Analysis Process (EIAP), the U.S. Air Force (USAF) has conducted an environmental assessment of the potential environmental consequences of the USAF *atmospheric interceptor technology* (*ait*) program. The No Action alternative was also considered. This Draft Finding of No Significant Impact (FONSI) summarizes the results of the evaluation.

Proposed Action and Alternatives: The Environmental Assessment (EA) is for the USAF *ait* program, which consists of two proposed sub-orbital missile launches. Congress directed the Ballistic Missile Defense Organization (BMDO) to provide funds to support the USAF National Missile Defense (NMD) initiative. The USAF plans to apply these funds to meet a requirement for a target launch capability that simulates inbound missile threat trajectories from potential Pacific Basin adversaries. In the interest of enhancing timely, economical national defense, this capability will be used to evaluate the performance and utility of existing radar systems to support potential low-cost, low-risk NMD architectures.

Two existing USAF radar systems have high potential for NMD application. The upgraded PAVE PAWS radar located at Beale Air Force Base (AFB), California is a wide-looking potential target detection element of a future NMD system. The HAVE STARE tracking radar located at Vandenberg AFB, California represents a candidate design to perform the narrow-looking target tracking radar role of a future NMD system. To fully understand the utility of these radar systems in an NMD role, the USAF has a requirement to integrate and test these systems using realistic threat scenarios. California is the only location where these radars are close enough to be tested together. The PAVE PAWS radar initially detects an incoming target and hands over specific tracking of the target to the HAVE STARE.

The proposed USAF *ait* program will consist of the preparation for and the launch of two sub-orbital test vehicles from the Kodiak Launch Complex (KLC) on Kodiak Island, Alaska. KLC is a commercial launch site being developed by the Alaska Aerospace Development

Corporation (AADC). Sub-orbital launches from this site can be detected and tracked by the PAVE PAWS and HAVE STARE radars in California to meet the needs of the USAF *ait* program.

The USAF *ait* test vehicles consist of deactivated Minuteman II second and third solid rocket motor stages that have been modified to be used as boosters for the test launches. As part of the USAF *ait* program, the test vehicles would carry an instrumentation package. The two USAF *ait* sub-orbital launches are proposed for July 1998 and March 1999.

In addition to the proposed action, the USAF considered various other alternatives for launching the *ait* test vehicles. These alternatives included sea and air launch systems; existing DoD launch sites; and other sites in Alaska other than Kodiak Island. Based on the alternative selection criteria established by the USAF to meet the mission objectives of the *ait* program, none of the alternatives meet all of the mission objectives; therefore, the alternatives were eliminated from further detailed analysis.

Under the No Action alternative, the USAF *ait* program would not be conducted. Impacts associated with the processing and launch of the two sub-orbital *ait* test vehicles would not occur. However, if the proposed action is not conducted, the existing operational, ground-based radar systems will not be tested regarding their capabilities to realistically detect, track, and evaluate simulated, inbound missile threat trajectories from potential Pacific Basin adversaries.

Anticipated Environmental Effects: The EA evaluated potential environmental impacts of the USAF *ait* test program. The two *ait* test vehicles would be launched from KLC. The construction and operation of AADC's KLC site was the subject of an EA conducted by the Federal Aviation Administration (FAA). The FAA EA was completed in June 1996 and a FONSI was signed by the FAA in October 1996. The FAA EA has been reviewed regarding potential impacts to the geology and soils, water, land use, socioeconomics, recreation, visual and cultural resources of Kodiak Island the KLC site. The USAF adopts the analysis and conclusions of the FAA EA for these topical areas.

To address potential impacts specific to the processing and launch of the USAF *ait* test vehicle from KLC, the USAF *ait* EA includes an analysis of air quality, biological resources, noise, health and safety, and hazardous materials and waste. The EA determined that the USAF *ait* test program would not result in significant impact relative to air quality, biological resources, noise, health and safety, or hazardous materials and waste.

Mitigation: The Steller's Eider, a seabird commonly found in this area during the winter, was recently listed as a federal threatened species. In accordance with the Endangered Species Act, the USAF is in informal Section 7 consultation with the U.S. Fish and Wildlife Service (USFWS).

For the two *ait* test vehicle launches, the USAF will, as a minimum, participate in the mitigation monitoring program for marine birds, including the Steller's eider, developed by the FAA.

Conclusion: Following a review of the attached EA, it is concluded that the USAF *ait* program will not result in significant environmental impacts, and therefore an Environmental Impact Statement (EIS) is not required for the USAF *ait* program. This document, and the supporting EA, fulfill the requirements of NEPA, CEQ regulations, and AFI 32-7061.

HELMUT HELLWIG
Deputy Assistant Secretary
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Date

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ACRONYMS

ait	*atmospheric interceptor technology*
$A1_20_3$	Solid alumina particles
AADC	Alaska Aerospace Development Corporation
AFB	Air Force Base
AFI	Air Force Instruction
BMDO	Ballistic Missile Defense Organization
C	Celsius
CEQ	Council on Environmental Quality
Cl_2	Chlorine
CO	Carbon monoxide
dB	decibel
dBA	decibel (A-Weighted Sound Level)
DoD	Department of Defense
DOT	Department of Transportation
EA	Environmental Assessment
EIAP	Environmental Impact Analysis Process
EIS	Environmental Impact Statement
FAA	Federal Aviation Administration
FONSI	Finding of No Significant Impact
ft/s	feet per second
HCl	Hydrogen chloride
KLC	Kodiak Launch Complex
KOH	Potassium hydroxide
km	kilometers
lbs	pounds
m/s	meters per second
mg/m^3	milligrams per cubic meter
NAWC	Naval Air Warfare Center Weapons Division
NEPA	National Environmental Policy Act
NMD	National Missile Defense
NMFS	National Marine Fisheries Services
NO	Nitrogen oxide

NOAA	National Oceanic and Atmospheric Administration
NO_x	Nitrogen oxide
ODS	ozone depleting substances
PM_{10}	Particulate matter (aerodiameter less than 10 microns)
ppb	parts per billion
ppm	parts per million
psf	pounds per square foot
REEDM	Rocket Exhaust and Effluent Diffusion Model
SFA	Spaceport Florida Authority
SMC/TEB	Space and Missile Systems Center, Test and Evaluation Directorate, Launch Test Program
SSI	Spaceport Systems International
T	Launch
USEPA	United States Environmental Protection Agency
USAF	United States Air Force
USFWS	United States Fish and Wildlife Service

GLOSSARY

2-Nitrodiphenylamine (2-NDPA)	Part of the M57 propellant, 1.00% of propellant by weight.
Abort	To end a planned missile flight before it is completed.
Acoustic	Refers to hearing and sound.
Air Force Instruction (AFI)	Air Force publication providing instruction.
Aloft	Into the air.
Altitude	The height above sea level.
Aluminum	Part of the SR-19 propellant.
Ambient	Completely around; circulating, as “ambient air .”
Ammonium Perchlorate	The oxidizer for the SR-19 and M57 propellant, 73% of propellant weight for SR-19 and 10.80% of propellant by weight for M57.
Amplitude	The height (or magnitude) of a wave form about a given axis.
Apogee	The point in an orbit that is the farthest distance from the earth.
Attenuation	To weaken or reduce; to become less.
Atomic Chlorine (Cl-)	A chlorine ion.
Auditory Trauma	Injury to a person’s or animal’s organs of hearing.

Azimuth	The direction the vehicle will travel about the launch point.
Bird Strikes	When a bird flies into a solid object.
Black Scoter	Sea bird common to the Narrow Cape area.
Boosters	Sources of thrust in the takeoff and early flight of a rocket.
Cadmium	A heavy metal used in the rocket batteries.
Carpet Boom	Sonic boom during descent of an airborne vehicle that is traveling faster than the speed of sound.
Celsius	Centigrade scale of temperature.
Clean Air Act	Federal legislation enacted in 1955 that governs substances discharged into the air.
Combustion Chamber	The area within a liquid rocket motor where the fuels combine, burn and develop thrust.
Cultural Resources	Historic and archaeological remains and artifacts.
Cyclotetramethylentetranitramine (HMX)	Part of M57 propellant, 10.80% of propellant by weight.
Debris Scatter	Fragments of an exploded rocket, spread over a large area.
Environs	Surrounding parts or areas.
Evacuate	To remove persons or things from a place, especially for reasons of safety.
Explosion	A violent bursting of noise and material.
EIS	Environmental Impact Statement. A federal environmental document.
Focal Zone	The leading edge of the missile from which a sonic boom originates.
FONSI	Finding of No Significant Impact. A decision that a project will not have a significant effect on the environment.
General Vicinity	Near.
Gravitational	The effect of gravity, which causes things to fall toward the earth.
Haulout Area	An area where marine animals, such as sea lions, come from the ocean onto the shore.
HAVE STARE	A research and development radar located on Vandenberg AFB, CA, used for tracking missiles.
Hydraulic Fluid	A thick liquid substance used in engines.
Hypergolic	Rocket fuel that combusts upon the mixing of a liquid fuel and liquid oxidizer.
Impact Zones	Areas where effects would occur.

Inbound	Moving toward a person or place.
Individuals	Each one of a group of persons, animals or things.
Intercontinental	Between the earth's continents. Able to travel from one continent to another.
Instrumentation Package	Front, or top, section of the *ait* vehicle that holds the various experiments.
Kilometer	A metric measure of distance that is 0.621 of one mile.
Launch Trajectory	The curve or path of a rocket in flight.
Launch Vehicle	Rocket that carries cargo into the air.
Minuteman II	A three-stage rocket developed by the U.S. Air Force.
Milligram	A unit of weight equal to 1/1,000 of a gram.
Missile Transporter Erector	A trailer designed to transport a two-stage (SR-19/M57) rocket and lift it vertically onto a fixed launch stool.
Molecular Chlorine (Cl_2)	Two atoms of chlorine in its natural gaseous state.
Navy 2P-3D Orion Aircraft or NP-3D Orion	A modified Navy P-3 aircraft that can track a missile, collect telemetry for a missile and (if the missile goes off course) initiate a destruct command that will cause the missile to stop acceleration.
Nickel	Metallic element used in the rocket batteries.
Nitrocellulose	Part of M57 propellant.
Nitrogen Oxide	A compound that contains nitrogen and oxygen.
Nitroglycerin	An explosive liquid. Part of M57 propellant.
Nominal Conditions	Flight conditions that occur as predicted.
NP-3D Orion	See Navy 2P-3D Orion Aircraft.
Oldsquaw	Seabird common to the Narrow Cape area.
Operational Threat Trajectories	Flight profiles that would be expected from a missile launch toward the U.S.
Ordnance	Military weapons and ammunition.
Ozone	A form of oxygen that helps protect the earth from the sun's rays.
Ozone Depleting Substances, Class I and Class II	Chemical matter that decreases the earth's ozone layer. Class I and II substances are as listed in Section 602 of the Clean Air Act (1990 amendments).
PAVE PAWS	An operational radar located on the central California coast used for tracking friendly and enemy missiles.
PCBOOM 3 Model	U.S. Air Force computer software used to predict and measure a sonic boom.

Pelagic Species	Marine plants or animals that live or grow at or near the surface of the ocean, far from land.
Plume Size and Drag	The size of the rocket exhaust and how much it slows down the rocket.
Polybutadiene (as binder)	Part of the SR-19 propellant, 12% of propellant by weight.
Postbreeding	The time after animals have finished breeding.
Potassium Hydroxide (KOH)	Caustic substance used in one of the seven batteries onboard the *ait* test vehicle.
Propagate	To transmit through space.
Radar	A device that determines the location of a solid object by using radio waves that "bounce" off of the object.
Range Control	The range safety organization function of controlling the flight of a rocket to ensure it stays on course.
Range Safety Program	Range function to ensure that all aspects of a missile launch and flight are done safely, including ground handling and missile flight.
Redundant Airborne Command Destruct Systems	All systems on the Navy NP-3D Orion have two systems for the command destruct function. If one system goes down, the second can complete the command destruct function.
Resorcinol	Trade name for an element of the M57 propellant, 1.08% of propellant by weight. Chemical name 1,3-Dihydroxybenzene.
RNOISE Model	U.S. Air Force computer software used to predict and measure on-pad and in-flight rocket noise.
Roadblocks	Large objects placed in a road to keep persons from driving on the road.
Rocket Exhaust and Effluent Dispersion Model (REEDM)	Computer software that measures air pollutants from rocket exhaust.
Rookery	A place where animals, such as seals and sea lions, breed.
Scoping Process	Procedures that let the general public learn about and make comments on the environmental effects of a proposed project.
Second Stage	The second rocket motor to fire.
Service Structure	Mechanism that lifts the rocket to an upright position so that it can be launched.
Socioeconomics	The interaction of persons and monetary issues within a society.
Solid Rocket Motor	Engine for rocket with fuel that is solid, not liquid.
Sonic Boom	A loud noise caused by the shock wave of a vehicle that is traveling faster than the speed of sound.
Startle	To be surprised; to act surprised.

Steller's Eider	Sea bird common to the Narrow Cape area.
Stratosphere	A part of the earth's atmosphere. It surrounds the earth on top of the troposphere and extends outward to about 15 miles from the earth's surface.
Sub-Orbital	Below an altitude necessary for an object to achieve an orbit, which is a path around the earth or other celestial body.
Surf Scoters	Sea bird common to the Narrow Cape area.
Surf Zone	The area near the shore where there is foamy water from waves breaking on the shore.
Topography	The contours, such as mountains and canyons, of the surface of the ground.
Toxic Materials	Substances that can be poisonous.
Trajectory	The curved path of a rocket in flight.
Triacetin	Part of the M57 propellant, 6.16% of propellant by weight.
Troposphere	A part of the earth's atmosphere. It surrounds the earth and extends from the surface of the earth to a distance ranging from 6 to 12 miles from the earth.
Vector	Instantaneous missile direction and velocity of the missile in flight.
Velocity	Speed of an object in motion.
White-Winged Scoters	Sea bird common to the Narrow Cape area.

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

1. This Environmental Assessment (EA) is for the United States Air Force (USAF) *atmospheric interceptor technology (ait)* program, which consists of two proposed sub-orbital missile launches. Congress directed the Ballistic Missile Defense Organization (BMDO) to provide funds to support the USAF National Missile Defense (NMD) initiative. The USAF plans to apply these funds to meet a requirement for a target launch capability that simulates inbound missile threat trajectories from potential Pacific Basin adversaries. In the interest of enhancing timely, economical national defense, this capability will be used to evaluate the performance and utility of existing radar systems to support potential low-cost, low-risk NMD architectures.

2. Two existing USAF radar systems have high potential for NMD application. The upgraded PAVE PAWS radar located at Beale Air Force Base (AFB), California is a wide-looking potential target detection element of a future NMD system. The HAVE STARE tracking radar located at Vandenberg AFB, California represents a candidate design to perform the narrow-looking, target tracking radar role in a future NMD system. To fully understand the utility of these radar systems in an NMD role, the USAF has a requirement to integrate and test these systems using realistic threat scenarios. California is the only location where these radars are close enough to be tested together. The PAVE PAWS radar initially detects an incoming target and hands over specific target tracking to the HAVE STARE.

3. Space and Missile Systems Center, Test and Evaluation Directorate, Launch Test Programs (SMC/TEB) proposes to launch two sub-orbital test vehicles as part of the USAF *ait* program to test these existing ground-based early warning radar systems with authentic inbound rockets, flying from north to south as they would if used in an actual attack.

4. The Environmental Impact Analysis Process (EIAP) for the proposed program is set forth in Air Force Instruction (AFI) 32-7061, Environmental Impact Analysis Process, which implements the National Environmental Policy Act (NEPA) and the President's Council on Environmental Quality (CEQ) regulations. Additional NEPA requirements are contained in Department of Defense (DoD) Regulation 5000.2, Mandatory Procedures for Major Defense Acquisition Programs.

5. This EA evaluates available DoD and commercial launch facilities that could support the launch of the USAF *ait* test vehicles while meeting the test objectives of the program. The USAF

included the evaluation of commercial launch sites to support the objectives of the Space Commercialization Act. The Space Commercialization Act encourages "…strengthening and expansion of the U.S. space transportation infrastructure, including the enhancement of U.S. launch sites and launch site support facilities, with Government, State, and private sector involvement." In 1995, SMC/TEB awarded a Spaceport Contract for the purpose of providing competitive, commercial "off-the-shelf" spaceport services to support SMC/TEB launch operations for both orbital and sub-orbital missions. The contract awardees are the Alaska Aerospace Development Corporation (AADC); Spaceport Systems International (SSI), California; Old Dominion University Research Facility, Virginia; and Spaceport Florida Authority (SFA).

6. Several potential alternative sites were considered but eliminated from further detailed analysis in this EA based upon site selection criteria developed for this proposed action. Based on the evaluation of potential alternatives sites, only the AADC commercial spaceport on Kodiak Island, Alaska, will meet the site selection criteria for the USAF *ait* program. The construction and operation of AADC's Kodiak Launch Complex (KLC) was the subject of an EA conducted by the Federal Aviation Administration (FAA). The FAA EA for KLC was completed in June 1996 and a Finding of No Significant Impact (FONSI) (Attachment 1) was signed for the KLC site by the FAA in October 1996. To avoid a repetitive discussion of the environmental issues associated with AADC's construction and operation of KLC previously discussed in the FAA EA, and to focus the USAF decision making process on the issues associated with the USAF *ait* program, the USAF adopts the FAA EA analysis and findings regarding the construction and operation of KLC. The location of the KLC site is shown in Figure 1.1.

7. To support the launch of USAF *ait* test vehicles, the following facilities will be required at KLC: Launch Control and Management Center, Launch Pad and Service Structure, and Integration and Processing Facility. These facilities will be designed and constructed by AADC.

8. This EA identifies, describes and evaluates the potential direct, indirect and cumulative environmental impacts of activities associated with the proposed launch by the USAF of two *ait* sub-orbital test vehicles. This EA also identifies other alternatives to the proposed action, including the No Action alternative, and describes mitigation measures necessary to prevent or minimize environmental effects. Based upon their review of this EA, the USAF decision

makers will determine whether the EA supports a FONSI or whether an Environmental Impact Statement (EIS) is required due to the potential of the proposed action to have significant environmental impacts.

9. Public safety is of paramount importance to this program; therefore, to eliminate physical risk to the public, areas that could be impacted in the event of a major launch failure will be evacuated. The evacuation area is expected to include a one-mile radius around the launch pad. The brief evacuation time period will extend for approximately four hours before launch to no more than one hour after launch. In the case of KLC, this would include the road providing access to Narrow Cape.

10. The following laws and Executive Orders were among those considered during the preparation of this EA:
    - National Environmental Policy Act
    - Endangered Species Act, as amended
    - Marine Mammal Protection Act
    - Clean Air Act, as amended
    - Archaeological Resources Protection Act
    - Clean Water Act
    - Marine Protection, Research and Sanctuaries Act
    - National Historic Preservation Act
    - Occupational Safety and Health Act
    - Pollution Prevention Act
    - Executive Order 11990, Protection of Wetlands
    - Executive Order 12898, Environmental Justice
    - Executive Order 12114, Environmental Affects Abroad of Major Federal Actions

CHAPTER 1.0
INTRODUCTION

1.0 INTRODUCTION

1.1 NEED AND PURPOSE FOR THE PROPOSED ACTION

1.1.1 NEED

1. To enhance the national defense, the USAF has a requirement to test its existing ground-based radar systems for detecting potential inbound missile threats. Specifically, the USAF has a requirement for a target launch capability that simulates inbound missile threat trajectories from potential Pacific Basin adversaries. To meet this requirement, the USAF proposes the *ait* program, with test objectives that mandate a trajectory that is capable of specific azimuths and altitudes to provide a threat-like scenario to existing operational ground-based radars. These operational ground-based radars will observe and evaluate the simulated inbound threat trajectory of the USAF *ait* sub-orbital test vehicles.

2. Two existing USAF radar systems have high potential for NMD application. The upgraded PAVE PAWS radar located at Beale AFB, California is a wide-looking potential target detection element of a future NMD system. The HAVE STARE tracking radar located at Vandenberg AFB, California represents a candidate design to perform the narrow-looking, target tracking radar role in a future NMD system. To fully understand the utility of these radars in an NMD role, the USAF has a requirement to integrate and test these systems using realistic threat scenarios. California is the only location where these radars are close enough to be tested together. PAVE PAWS radar initially detects an incoming target and hands over specific target tracking to the HAVE STARE.

1.1.2 PURPOSE

The purpose of the proposed action is to evaluate the performance and utility of existing radar systems to support potential low-cost, low-risk NMD architectures. Testing the operational ground-based radar system requires the launch of a test vehicle that can be simultaneously detected and tracked by both systems. The USAF *ait* program will allow the evaluation of the systems' capabilities to simultaneously acquire and accurately track the test vehicle and to manage data.

1.2 ALTERNATIVE SELECTION CRITERIA

For a site to support the USAF *ait* program, it must meet the following criteria:

- Radar Coverage: The site must be located to allow launches to simulate inbound hostile threat trajectories, and confirm the ability of existing U.S. early warning PAVE PAWS and HAVE STARE radar sites in California to detect the test vehicle.
- Overflight: The site must be located to avoid overflight of populated areas and to minimize overflights of environmentally sensitive areas.
- Logistics: The site must have year-round access to transportation infrastructure, such as air cargo and barge systems.
- Weather: The site must be located in an area with weather compatible with the launch of sub-orbital solid rocket motor test vehicles.
- Range: The site must be located within a maximum of 2,000 kilometers (km) from the radar coverage area to accommodate the range of the two-stage USAF *ait* test vehicle and to provide trajectories into the early warning radar coverage.
- Launch Vehicle: The launch vehicle must consist of existing proven, low-cost, low-risk USAF assets.

1.3 SCOPE OF THE ENVIRONMENTAL ASSESSMENT

1. Requirements of NEPA and the implementing regulations of the President's CEQ require federal agencies (e.g., the USAF) to evaluate the impact that their proposed actions would have on the environment. The purpose of this EA is to fulfill those requirements for the USAF *ait* program and to make the USAF decision makers aware of potential environmental consequences of proposed action and alternatives.

2. Several potential alternatives were considered but eliminated from further detailed analysis in this EA based upon selection criteria described above developed for this proposed action. As explained more fully below, based on the evaluation of potential alternatives, only the AADC commercial spaceport on Kodiak Island, Alaska, will meet the selection criteria for the USAF *ait* program. The construction and operation of AADC's KLC was the subject of an EA conducted by the FAA. The FAA EA for KLC was completed in June 1996 and a FONSI (Attachment 1) was signed for the KLC site by the FAA in October 1996. To avoid a repetitive discussion of the environmental issues associated with AADC's construction and operation of KLC previously discussed in the FAA EA, and to focus the USAF decision making process on the issues associated with the USAF *ait* program, the USAF adopts the FAA EA analysis and findings regarding the construction and operation of KLC. The location of the KLC site is shown in Figure 1.1.

3. To assist in identification of the scope of the EA for the USAF *ait* program, the USAF conducted a scoping process to solicit input from the public regarding issues that were considered during preparation of the EA. Through a series of public announcements, press releases, purchased newspaper display advertisements, and an Internet notice, the USAF requested review and comment from the public. A summary of the issues raised during the scoping process is provided in Appendix A of this USAF EA. In addition to the public scoping process, the USAF is continuing to consult with federal and state agencies.

4. Potential impacts associated with the two sub-orbital launches of the USAF *ait* test vehicles are identified and analyzed herein. In addition to the FAA EA, this EA addresses environmental impacts associated with the launch of two USAF *ait* test vehicles, including an analysis of air quality, biological resources, noise, health and safety, and hazardous materials. This analysis will result in either a FONSI or a finding that an EIS must be prepared.

1.4 DECISION TO BE MADE

The decision to be made regarding the USAF *ait* program is whether to:

- Proceed with the two sub-orbital launches of the USAF *ait* test vehicle from KLC to challenge the existing ground-based radar systems' ability to rapidly acquire and accurately track the test vehicle, as well as the systems' capabilities to manage data.
- Take no action (i.e., No Action alternative) and not launch the two USAF *ait* test vehicles and not conduct the test of the existing ground-based radar system.

1.5 PERMITS, APPROVALS AND CONSULTATIONS

1. The FAA and AADC has or is obtaining various permits and approvals for operation of the KLC. Table 1.1 lists these permits and approvals pertinent to the USAF *ait* program. The USAF is working directly with FAA and with the appropriate agencies (U.S. Fish and Wildlife Service [USFWS] and National Marine Fisheries Service [NMFS]) to assure that the *ait* program is in compliance with federal and state regulations, including the permits and approvals obtained by AADC.

2. Section 7 of the Endangered Species Act requires federal agencies to consult with the USFWS to determine if their actions have the potential to impact threatened or endangered species. Based on the recent listing of the Steller's eider, the USAF is in informal Section 7 consultation with the USFWS for the *ait* program.

3. The USAF is also addressing the issues of air space and maritime traffic. The USAF is coordinating with the FAA regarding commercial airspace corridors, and the FAA is a cooperating agency for this EA. The USAF is working with the U.S. Coast Guard on maritime traffic impacts.

CHAPTER 2.0
DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES (DOPAA)

2.1 PROPOSED ACTION

1. The USAF proposes to launch two sub-orbital test vehicles from the AADC's KLC on Kodiak Island, Alaska, in support of its *ait* program. The two launches of the USAF *ait* test vehicle would simulate potential incoming missile threat trajectories to allow the USAF to evaluate its early warning ground-based system for potential incoming missile attacks on the United States.

2. The USAF *ait* test vehicle is approximately 37 feet long, weighs 21,910 pounds and consists of deactivated Minuteman II second and third solid rocket motor stages. These stages have been modified to be used as boosters for the test launches. DoD has successfully launched six vehicles with a configuration similar to the *ait* test vehicle. As part of the *ait* program, the test vehicle would carry an instrumentation package. The first USAF *ait* launch is proposed for July 1998 with the second launch proposed for March 1999.

3. The location of Kodiak to launch the two sub-orbital *ait* test vehicles is proposed because it meets the *ait* program selection criteria. The proposed *ait* launches would occur from the KLC being developed by the AADC. The KLC site is located on the eastern shore of Kodiak Island on Narrow Cape, approximately 40 miles south of the City of Kodiak, Alaska (see Figures 2.1 and 2.2).

2.1.1 LAUNCH TRAJECTORY

The USAF *ait* vehicle flight profile is a sub-orbital ballistic trajectory that is approximately 1,820 km in range with an apogee of 810 km. At the end of the flight, the *ait* instrumentation package would splash down into the Pacific Ocean approximately 300 km off the coast of southern Washington state. The first stage of the USAF *ait* test vehicle would separate at launch (T) +60 seconds. The expended first stage would impact in the Pacific Ocean approximately 300 km downrange. The second stage would release the *ait* instrumentation package at T+123 seconds and would impact in the Pacific Ocean just short of the *ait* instrumentation package splashdown point. The *ait* instrumentation package would continue coasting until splashdown at T+1,022 seconds. The maximum vehicle velocity would be approximately 13,000 feet per second (ft/s) or Mach 14. Impact velocity would be approximately 800 ft/s.

2.1.2 VEHICLE PROCESSING

The following process would be followed to transport the USAF *ait* test vehicles to KLC and ready the vehicles for launch:

- The USAF *ait* test vehicle would be configured at Hill AFB, Utah.
- The USAF *ait* test vehicles would be placed in a Missile Trailer (Rocket Motor Semi-Trailer) and transported by a C-5 or C-17 aircraft from Hill AFB to the Kodiak Airport.
- The Missile Trailer is highway approved. A certified commercial carrier would be contracted to transport the Missile Trailer containing the USAF *ait* test vehicle from the Kodiak Airport to the KLC site via Kodiak Island Highway and Pasagshak Point Road (see Figure 2.1).
- A modified Missile Transporter Erector would be delivered to Kodiak by aircraft or barge and would be driven to KLC.
- The *ait* instrumentation package would be transported to Kodiak via aircraft and transported to KLC by truck. Upon arriving at KLC, it would be placed in the Integration and Processing Facility for prelaunch processing. The *ait* instrumentation package would be integrated with the USAF *ait* test vehicle in the Integration and Processing Facility.
- In the Integration and Processing Facility, the USAF *ait* test vehicle would be removed from the Missile Trailer and placed in the Transporter Erector. The Transporter Erector would move into place at the Launch Pad/Service Structure and erect the USAF *ait* test vehicle onto the launch stool.
- Final testing and checkout of the integrated USAF *ait* test vehicle and instrumentation package would be completed in the Service Structure at the Launch Pad.
- Upon completion of processing, the USAF *ait* test vehicle would be launched. Range safety for the *ait* launches would be provided by the Naval Air Warfare Center safety office at Point Mugu, California. The Navy would use NP-3D Orion aircraft to provide range safety functions for the USAF *ait* test vehicle launches. In addition to range safety support provided by the Navy, USAF personnel and equipment will be certified to accomplish range safety operations.

2.2 KLC FACILITIES

2.2.1 FACILITY OVERVIEW

The AADC is developing the KLC from which the USAF proposes to launch two USAF *ait* test vehicles. The KLC will occupy 43 acres on a 3,100-acre parcel of state owned property. Facilities that will be constructed by AADC will consist of a Launch Control and Management Center (see Figure 2.3), Payload Processing Facility (see Figure 2.4), Integration and Processing Facility, and Launch Pad and Service Structure (see Figure 2.5). Support facilities at KLC will include access roads, water, power, communications and sewage disposal. For a more detailed discussion of the KLC launch site and its facilities, the reader is referred to the FAA EA included as Attachment 1 to this USAF EA.

2.2.2 CONSTRUCTION OF KLC

AADC is responsible for design and construction of the three facilities (i.e., Launch Control/Management Center, Integrated and Processing Facility, and Launch Pad/Service Structure) that are proposed to be used by the USAF *ait* program. Construction of the KLC facilities and infrastructure is addressed in detail in the FAA EA that is included as Attachment 1 to this USAF EA.

2.3 ALTERNATIVES

In addition to the proposed action, the USAF considered various other alternatives for launching the *ait* test vehicles. However, these alternatives were eliminated from further detailed analysis in this EA as they did not meet the selection criteria outlined in Section 1.2. The following sections provide a summary of these alternatives and the reason they were eliminated from further detailed analysis.

2.3.1 ALTERNATIVES CONSIDERED BY THE USAF, BUT ELIMINATED FROM DETAILED ANALYSIS

1. USAF considered ground, sea, and air launch systems. Sea and air launches were eliminated because they did not meet the selection criteria of existing proven, low-risk, low-cost USAF assets.

2. The USAF evaluated the five existing DoD launch sites as possible alternatives located outside the state of Alaska for launching the sub-orbital *ait* test vehicle (Figure 2.6). As shown in Table 2.1 and as summarized below, none of the DoD existing launch site can meet all of the *ait* mission siting criteria.

   - Wake Island: This site is not within the range to launch the USAF *ait* test vehicle into the radar coverage of the ground-based radar systems in California that are to be tested by the *ait* program.
   - Kauai, Hawaii (Barking Sands): This site is not within range to launch the USAF *ait* test vehicle into the radar coverage of the ground-based radar systems in California that are to be tested by the *ait* program. In addition, launching the USAF *ait* test vehicle from this site would result in overflight of populated areas in Hawaii.
   - White Sands, New Mexico: This site cannot launch the USAF *ait* test vehicle into the radar coverage of the ground-based radar systems in California that are to be tested by the *ait* program. Launches would also overfly populated areas.
   - Eastern Test Range, Florida: This site is not within range and cannot launch the USAF *ait* test vehicle into the radar coverage of the ground-based radar systems in California that are to be tested by the *ait* program. In addition, launches would overfly populated areas.
   - Western Test Range, California: This site cannot launch the USAF *ait* test vehicle into the radar coverage of the ground-based radar systems in California at a trajectory that would simulate a potential inbound missile threat.

   Therefore, the use of the existing DoD launch sites for launching the USAF *ait* test vehicle was eliminated from further consideration.

3. The USAF also evaluated four sites other than Kodiak Island within the state of Alaska (see Figure 2.7) using the same criteria as the sites outside of the state. As shown in Table 2.2 and as summarized below, the USAF concluded that only Kodiak Island in the state of Alaska meets the *ait* mission siting criteria.

   - Poker Flats: This site is not within range and cannot launch the USAF *ait* test vehicle into the radar coverage of the ground-based radar systems in California that are to be tested by the *ait* program. In addition, launches would overfly populated areas.
   - Elmendorf AFB: This site would result in the overflight of populated areas of Alaska.
   - Point Barrow: This site would result in the overflight of populated areas of Alaska and cannot launch the USAF *ait* test vehicle into the radar coverage of the ground-based radar systems in California that are to be tested by the *ait* program. In addition, Point Barrow does not provide year-around access to transportation infrastructure.

- Adak Island: This site is not within range and cannot launch the USAF *ait* test vehicle into the radar coverage of the ground-based radar systems in California that are to be tested by the *ait* program. This site does not provide year-around access to transportation infrastructure.
- Kodiak Island-Narrow Cape: This site meets all of the *ait* mission siting criteria.

Therefore, with the exception of Kodiak Island-Narrow Cape, the other sites in Alaska were eliminated from further consideration.

4. Based on the above, AADC's KLC on Kodiak Island is proposed as the site to launch the USAF *ait* test vehicle.

2.3.2 NO ACTION ALTERNATIVE

Under the No Action alternative, the USAF *ait* program would not be conducted. Impacts associated with the processing and launch of the two sub-orbital *ait* test vehicles would not occur. If the proposed action is not conducted, the existing operational, ground-based radar systems will not be tested regarding their capabilities to realistically detect, track, and evaluate simulated, inbound missile threat trajectories from potential Pacific Basin adversaries.

CHAPTER 3.0
AFFECTED ENVIRONMENT

3.0 AFFECTED ENVIRONMENT

3.1 GEOLOGY AND SOILS, WATER, LAND USE, SOCIOECONOMICS, RECREATION, VISUAL AND CULTURAL RESOURCES

The FAA EA has been reviewed by the USAF regarding the existing geology and soils, water, land use, socioeconomics, recreation, visual and cultural resources of Kodiak Island and the proposed KLC site, the area potentially affected by the proposed processing and launch of the USAF *ait* test vehicle. The USAF adopts those portions of the FAA EA describing the existing environment regarding geology and soils, water, land use, socioeconomics, recreation, visual and cultural resources. The FAA EA is included as Attachment 1 to this USAF EA.

3.2 AIR QUALITY

1. The FAA EA has been reviewed regarding the existing air quality at Kodiak Island and the proposed KLC site, the area potentially affected by the proposed processing and launch of the USAF *ait* test vehicle. The USAF adopts those portions of the FAA EA describing the existing environment regarding air quality. It has been determined that the air quality analysis provided in the FAA EA on construction and pre/postlaunch operations is complete and sufficient.

2. In addition to the analysis provided in the FAA EA, this document EA provides an analysis of the lower and upper atmospheric air emissions from launch of the two USAF *ait* test vehicles.

3.2.1 LOWER ATMOSPHERE

For the purpose of this EA, the term "lower atmosphere" is used for the analysis of ground level emissions and emissions that occur within the troposphere, which extend from the ground surface to an altitude of approximately 15 km. This is the region of the atmosphere in which people are directly affected by air emissions from world-wide industrial society.

3.2.2 UPPER ATMOSPHERE

For the purpose of this EA, the term "upper atmosphere" refers to the stratosphere, between the altitudes of approximately 15 km and 40 km. The actual extent of the stratosphere varies as a function of latitude and season. The stratosphere contains the Earth's ozone layer that protects the Earth's surface from harmful ultraviolet radiation. Most substances which deplete stratospheric ozone are regulated by the U.S. Environmental Protection Agency (USEPA) under the Clean Air Act. Hundreds of chemical reactions are involved in maintaining and depleting the Earth's stratospheric ozone layer. Some of these atmospheric reactions can be affected by the addition of certain chemicals from launches.

3.3 BIOLOGICAL RESOURCES

1. The FAA EA has been reviewed regarding existing biological resources of Kodiak Island and its environs in general, and the proposed KLC site in particular. The USAF adopts those portions of the FAA EA describing the existing environment regarding biological resources. However, this USAF EA includes a discussion of the Steller's eider (*Polysticta stelleri*), a sea bird, because the USFWS listed it as a threatened species after the release of the FAA EA. Additional discussion on the Steller's eider is provided below.

2. For a detailed description of the existing environment regarding other biological resources, the reader is referred to the FAA EA.

3.3.1 STELLER'S EIDER

1. As discussed in the FAA EA, the strait between Narrow Cape and Ugak Island attracts marine birds on a year-round basis because of its shallow waters and abundance of food (i.e., fish and invertebrates) (Environmental and Natural Resource Institute [ENRI], 1995). Eiders and sea ducks common to the area include king eiders, Steller's eiders, harlequin ducks, oldsquaw, black scoters, surf scoters, and white-winged scoters. These species occur in large numbers from November to May. Steller's eiders, which breed during the summer in the area of Point Barrow, Alaska, are a common winter resident in the waters off Kodiak Island, with up to 600 individuals having been observed in the nearshore waters off Narrow Cape (ENRI, 1995).

2. On July 11, 1997, the USFWS determined the Alaska breeding population of the Steller's eider to be threatened pursuant to the Endangered Species Act of 1973, as amended. This determination was based upon a substantial decrease in the species' nesting range in Alaska, a reduction in the number of Steller's eiders nesting in Alaska, and the resulting increased vulnerability of the remaining breeding population to extirpation. Critical habitat for the Steller's eider has not been designated by the USFWS at this time (Federal Register,

June 11, 1997; Vol. 62, No. 112). Section 7 of the Endangered Species Act requires consultation with the USFWS to assure that federal actions do not impact threatened or endangered species.

3.4 NOISE

1. The FAA EA has been reviewed regarding the existing noise environment of Kodiak Island and the proposed KLC site, the area potentially affected by the proposed processing and launch of the USAF *ait* test vehicles. The USAF adopts those portions of the FAA EA describing the existing environment regarding noise.

2. However, to address the specific noise impacts associated with the launch of the two USAF *ait* test vehicles, noise and sonic boom analyses have been conducted. The results of these analyses are discussed in Section 4.4.

3.5 HEALTH AND SAFETY

1. The FAA EA has been reviewed regarding public health and safety as it relates to the operation of facilities and launches from KLC. The USAF adopts those portions of the FAA EA describing the environment regarding health and safety, except for a specific analysis of the potential health and safety issues directly related to the launch of the two USAF *ait* test vehicles from KLC. Therefore, this section provides information regarding health and safety for the USAF *ait* program at KLC.

2. The reader is referred to the FAA EA for a detailed description of the existing environment regarding health and safety.

3.5.1 PUBLIC HEALTH AND SAFETY

1. Public health and safety issues related to the USAF *ait* program arise from activities involving preflight transport and storage of missile components, missile launch and missile flight. A major launch failure could potentially involve an explosion, missile debris, release of toxic materials into the air or water, high noise levels, and/or fire. Hazardous operations associated with the USAF *ait* program involve the use of explosives, flammable or toxic products and high-pressure gases.

2. The regulatory environment for health and safety issues consists of existing regulations and practices that have been established to minimize or eliminate potential risks to the general public from activities associated with the launch of a missile such as the USAF *ait* test vehicle. These regulations and practices include, but are not limited to, Department of Transportation (DOT) regulations and USAF procedures for transporting hazardous materials, DoD procedures for handling explosives, and the DoD range safety program for the processing and launch of missiles, such as the USAF *ait* test vehicle.

3. DoD has an existing range safety program which is utilized to determine areas that will be evacuated for each mission. The objective of the program is to assure that the public is not exposed to unacceptable levels of risk. Range safety policies require areas that could be exposed to missile debris to be evacuated even though there is minimal risk to the public. The use of designated impact zones assures that the risk to the public is eliminated, physical security and safety measures can be enforced, and adverse environmental effects are minimized. The size of the evacuation area is determined based upon the potential for variability of the impact due to influences of local weather conditions, and small variances in the missile guidance and engineering systems.

4. The population of concern for the proposed action consists of persons in the general vicinity of the KLC site, U.S. Coast Guard personnel who periodically work at the Loran-C Station at Narrow Cape, and members of the public who utilize the site for recreation. In addition, other residents of eastern Kodiak Island, including Kodiak City and the U.S. Coast Guard Station, are included when considering public safety.

5. Other than individuals at the onsite Loran-C Coast Guard Station and at a private ranch, few members of the general public utilize the KLC site. In addition, the adjoining area is sparsely populated. Kodiak City and the U.S. Coast Guard Station, located approximately 30 to 40 miles from KLC, are the only sizable population centers on the island. The range safety program will assure that potential impacts will be well within the debris limit corridor (see Figure 4.5-1).

3.5.2 RANGE SAFETY

1. Although no new test range will be created as a result of the proposed action and there is no existing test range associated with the proposed action, standard range safety operations for the USAF *ait* program will be applied in accordance with regulations established

for Sea Test Ranges at the Naval Air Warfare Center Weapons Division (NAWC), Point Mugu, California (U.S. Navy, 1997). These procedures provide for flight safety, range clearance and surveillance, commercial air traffic control and ground safety. Included in these procedures are published notice to pilots (i.e., notice to airmen) and notice to ships and boats (i.e., notice to mariners), and coordination with the FAA and U.S. Coast Guard.

2. The NAWC has overall responsibility to assure that all aspects of safety are covered, including transport of hazardous materials (i.e., solid rocket motors), handling of the motors once they arrive at KLC, operations at the launch site and flight safety. The NAWC is responsible for assuring that the USAF *ait* test vehicle under any flight condition will not endanger any life or property. Because of the remote location of the launch site, NAWC will use two NP-3D Orion aircraft to provide monitoring and command destruct of the USAF *ait* test vehicle.

3. During launch preparation activities, ground safety at KLC will be the responsibility of NAWC, with assistance provided by USAF personnel. Hazardous operations will be performed in compliance with mission-specific operating procedures that will provide the requirements and direction for the activities at KLC, including explosives handling safety, hazardous operations control, explosives storage, launch pad operations and launch. Applicable safe operating procedures will be followed in conjunction with DoD Explosives Safety Standard 6055.9 and NAVSEA OP 5, Volume 1, *Technical Manual for Ammunition and Explosive Ashore, Safety Regulations for Handling, Storage, Production, Renovation and Shipping*.

4. During a launch, various contingencies will be in place to cover emergency situations. These include, but are not limited to:
   - Rocket Motor Mishap: There will be an Explosive Ordnance Disposal Plan in place with appropriate personnel and equipment.
   - Fire: There will be a firefighting crew in place during launch countdown.
   - Injury: An evacuation plan will be in place to transport injured persons by appropriate means as dictated by seriousness of injury.

3.6 HAZARDOUS MATERIALS AND WASTE

1. The FAA EA has been reviewed regarding hazardous materials that would be utilized and/or result from launch operations at KLC. The USAF adopts those portions of the FAA EA describing the existing environment regarding hazardous materials and waste. However, this section provides information specific to characteristics of the USAF *ait* test vehicles.

2. For a detailed description of other hazardous materials that will be utilized at KLC, the reader is referred to the FAA EA.

3. The USAF *ait* test vehicle contains the following hazardous materials or fuels.
   - Ammonium Perchlorate
   - Nitroglycerin
   - 2-Nitrodiphenylamine (2-NDPA)
   - Nitrocellulose
   - Cyclotetramethylentetranitramine (HMX)
   - Resorcinol (1,3-Dihydroxybenzene)
   - Triacetin
   - Hydraulic Fluid

4. Except for the hydraulic fluid, the above substances are suspended in a binder matrix within the two solid rocket motors. The hydraulic fluid is enclosed in the vector control system and nozzle control system. Under nominal conditions, hazardous materials related to the *ait* test vehicle do not present a potential impact.

5. Small amounts of potentially hazardous substances, hydrogen chloride gas (HCl), solid alumina particles (Al_2O_3), carbon monoxide gas (CO), nitrogen oxide gas (NO) and chlorine gas (Cl_2) would occur as a result of vehicle launch or abort.

CHAPTER 4.0
ENVIRONMENTAL CONSEQUENCES

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 GEOLOGY AND SOILS, WATER, LAND USE, SOCIOECONOMICS, RECREATION, VISUAL AND CULTURAL RESOURCES

The FAA EA has been reviewed regarding potential impacts to the geology and soils, water, land use, socioeconomics, recreation, visual and cultural resources of Kodiak Island and the proposed KLC site, the area potentially affected by the proposed processing and launch of the USAF *ait* test vehicle. The USAF adopts the analysis and conclusions of the FAA EA with regard to geology and soils, water, land use, socioeconomics, visual and cultural resources. Therefore, no further discussion with regard to these matters is provided. The FAA EA is included as Attachment 1 to this USAF EA.

4.2 AIR QUALITY

4.2.1 PROPOSED ACTION

The FAA EA has been reviewed regarding potential impacts to air quality from the construction and operation of KLC. The USAF adopts the analysis and conclusions of impacts to air quality in the FAA EA with regard to construction of the KLC for pre/postlaunch operations in general. The USAF determined that a specific analysis of air quality impacts related to the launch of the two USAF *ait* test vehicles would be included in this USAF EA. The results of that analysis are discussed below. A detailed air quality analysis for the launch of the two *ait* test vehicles is included in Appendix B.

4.2.1.1 Lower Atmosphere *ait* Emissions

1. The USAF *ait* sub-orbital test vehicle will not require the use of Class 1 or Class II ozone depleting substances (ODS) in the operation or maintenance of the *ait* systems, subsystems, components or processes. Therefore, there will be no ground-level ODS emitted as a result of processing the USAF *ait* test vehicle at KLC. Since prelaunch processing of the two USAF *ait* test vehicles will be minimal, ground-level activities involving substances other than ODS also are not expected to impact air quality.

2. Within the lower atmospheric region, ground-level air emissions from launch of the USAF *ait* test vehicle are the primary consideration. Computer model calculations have been performed to estimate air emissions from both normal launches and ground-level catastrophic

aborts of the USAF *ait* test vehicle at KLC. A description of the Rocket Exhaust and Effluent Diffusion Model (REEDM),Version 7.07 used for these calculations is provided in Appendix B.

3. To model and calculate the ground-level emissions, two meteorological cases were analyzed to correspond to the proposed launches of the *ait* test vehicle from KLC in July 1998 and March 1999. Normal temperatures and wind speeds for the months of March and July were obtained from National Oceanic and Atmospheric Administration (NOAA) data available for Kodiak. Onsite year-round records are not available for Narrow Cape.

4. On Kodiak, wind direction is independent of the time of year, with the main seasonal variations being temperature and wind speed. The average wind speeds used in the REEDM analysis for the *ait* program are 5.55 meters per second (m/s) in March and 3.45 m/s in July. These values are close to the yearly average of 4.9 m/s from a prevailing northwest direction. The calculations would not change significantly if a different launch month was selected. The dispersion model is not highly sensitive to temperature, but typical temperatures of 12.4 Celsius (C) for July and 0.5 C for March were used for the *ait* analyses. A worst-case wind condition, which is nearly calm out of the west, was also treated. The worst-case wind occurs 2 percent of the time throughout the year (FAA, 1996). No meteorological constraints on launching due to vehicle emissions have been identified for the *ait* flights from KLC.

5. Pollutant concentrations versus distance downwind were calculated for a normal *ait* launch and for an aborted launch for the two launch periods and for typical and calm wind conditions. The resultant peak pollutant concentrations versus distance downwind are shown in Appendix B, Figures 1 through 8. For a normal launch case, five pollutants are predicted; Al_2O_3, HCl, CO, NO and Cl_2. For the abort case, only three pollutants are tracked since the model does not predict the formation of NO or Cl_2. Because KLC is near the ocean, a significant fraction of the gas phase HCl will condense in the marine aerosol. This will lower the gas phase concentrations, but will also retard ground deposition and will reevaporate in several minutes, leaving downwind concentrations unchanged (Brady, 1997).

6. For normal launches, the four wind/month conditions result in similar maximum concentrations of the five pollutants. The concentrations for gas phase pollutants are less than 0.5 parts per million (ppm) for locations downwind; none but HCl exceeds 0.05 ppm

Revision. Figures 1 through 4 in Appendix B show where the peak concentrations of each pollutant occur for each of the nominal launch conditions. As the wind speed increases, the peak is reduced and occurs a greater distance from the launch site.

7. Figures 5 through 8 of Appendix B show that, for the *ait* launch abort cases, the three pollutant concentrations downwind are expected to be lower than for normal launches. This is because solid propellant burns more slowly in the open than in a rocket motor, and because the explosion is expected to scatter chunks of solid propellant over a wider area. The downwind range of peak concentrations is larger for the abort cases; this is consistent with the scattering of solid-rocket propellant in an explosion. The peak concentrations are lower for the calm wind cases in the abort scenario. Season does not affect peak concentrations.

8. The one-hour average exposure for a person coincidentally situated at the location of peak concentration downwind from an *ait* launch is less than 0.025 ppm (see Figure 9, Appendix B) for the conditions analyzed. The Occupational Health and Safety Administration (OHSA) personnel exposure limit for HCL is 5 ppm on an eight-hour basis. The USAF Space Command Surgeon's Office recommends an instantaneous maximum HCl exposure of no greater than 10 ppm to sensitive human populations on or near Vandenberg AFB and Cape Canaveral Air Station. That level of exposure would pose some risk to the average individual but would not cause permanent health effects. For exposures above 10 ppm, persons should seek shelter or remove themselves from the area. Discomfort may also be felt at a 2 ppm one-hour average, or at instantaneous exposure of 10 ppm, but no hazard to healthy individuals occurs at that level. The HCl concentrations of 0.025 ppm resulting from the *ait* launches fall far below these levels.

9. The concentrations of Al_2O_3 downwind from an *ait* launch or abort are given in milligrams per cubic meter (mg/m^3) in Figures 1 through 9 of Appendix B. The USAF has not established exposure standards for alumina particles. However, the concentrations of $A1_2O_3$ may be used for cumulative air quality considerations of particulate matter (aerodiameter less than 10 microns [PM_{10}]). Figures 1 through 8 of Appendix B show that Al_2O_3 concentrations are expected to be less than 2 mg/m^3, while 60-minute maximum exposures would be less than 0.25 mg/m^3.

10. Because the FAA EA for KLC indicated that the highest concentrations of launch emissions were found on an uninhabited mountain 5 km east of the launch site, that location was evaluated for each *ait* scenario discussed above. In the prevailing wind cases, concentrations

at the mountain site are zero except for Al_2O_3. For the calm wind cases, the Al_2O_3 concentration is approximately 30 percent smaller than the peak concentrations; the other chemical species are a factor of 5 to 10 smaller than their respective peak concentrations.

11. The difference between the results presented in the FAA EA and those in this USAF EA are due to the fact that the mountain site is located inland from the launch pad, whereas many of the peak concentrations shown in Figures 1 through 8 in Appendix B, especially in the prevailing wind cases, will occur over the open ocean.

12. In conclusion, HCl is the main gas phase pollutant released during the *ait* launch events. Its concentration will be below 0.5 ppm, while the 60-minute mean concentrations will be below 0.025 ppm. The peak levels are expected to occur at unpopulated locations downwind of the launch site. In addition, the levels would not be harmful to individuals should exposure occur. As addressed in the FAA EA, these levels would not result in significant impacts to plants or animals from the two USAF *ait* test vehicle launches. Other gas phase pollutant concentrations will be an order of magnitude smaller.

4.2.1.2 Upper Atmosphere *ait* Emissions

1. The first and second stage solid rocket motors of the USAF *ait* test vehicle produce exhaust emissions containing chlorine compounds. The primary chlorine compound produced at the nozzles of each of the two stages is HCl. Through high temperature afterburning reactions in the exhaust plume, the HCl is partially converted to atomic chlorine and molecular chlorine (Cl and Cl_2) (Burke and Zittel, 1997; Zittel, 1994). These more active forms of chlorine can contribute to localized ozone depletion in the wake of the launch vehicle, and also to the overall global chlorine loading which contributes to long-term ozone depletion. The HCl remains in the stratosphere for about three years, and then diffuses down to the troposphere . Details of the computer models used to generate the emission quantities are provided in Appendix B.

2. The USAF *ait* test vehicle will spend approximately 25 seconds in the stratosphere between 15 and 40 km. The first stage of the USAF *ait* test vehicle will deposit approximately 400 pounds (lbs) of HCl and approximately 550 lbs of combined Cl and Cl_2 between 15 km and 34.6 km (burn-out). This represents less than 30 lbs of active chlorine being distributed per km of altitude by the first stage. The second stage, which ignites at an altitude of 34.6 km, will contribute a total of approximately 6 lbs of HCl, Cl and Cl_2 between ignition

and 40 km altitude. It is estimated that less than 1 lb per km of altitude of the active forms of chlorine would be emitted by the second stage. Due to the large air volume over which these emissions would be spread, and because of rapid dispersion by stratospheric winds, the active chlorine from the two USAF *ait* test vehicle launches would not contribute to localized ozone depletion. Since the two proposed *ait* launches are spaced eight months apart, there is no local cumulative effect in the stratosphere from chlorine compounds generated by the *ait* launches. On a global scale, a total of 1,912 lbs of chlorine will be added to the stratosphere from both launches. This amount is a very small fraction of chlorine compared to other solid rockets in use.

3. Two other types of substances, Al_2O_3 and nitrogen oxide (NO_x) species, are also of concern with respect to stratospheric ozone depletion. The Al_2O_3, which is emitted as solid particles, has been the subject of study with respect to ozone depletion via reactions on solid surfaces. The studies (Molina 1996) indicate that Al2O2 can activate chlorine. The exact magnitude of ozone depletion that can result from a build-up of Al_2O_3 over time has not yet been determined quantitatively, but will be insignificant bases on existing analysis.

4. Exhaust from the first stage of the *ait* vehicle is approximately 27 percent by weight Al_2O_3, and the second stage exhaust is 35.4 percent Al_2O_3 by weight. The total amount of Al_2O_3 deposited between 15 and 40 km by each *ait* flight is approximately 1,180 lbs from the first stage and 83 lbs from the second stage. The Al_2O_3 is in the form of smooth particles with sizes varying in diameter from less than 1 micron to 10 microns (Beiting, 1997). Depending on the altitude of injection, the particles diffuse out of the stratosphere in time periods varying from weeks to a few years. The particles will participate in reactions (which may cause ozone depletion) (Molina 1996) during the limited time they stay in the stratosphere (Jackman, 1996). The Al_2O_3 solid particles would add to the overall atmospheric burden of particles until they eventually migrate downward to the ground, but because of the large volume of the stratosphere and rapid horizontal mixing, they would not significant cause localized effects on stratospheric ozone. On a regional or global scale, the chlorine and alumina will add to the total chemicals in the stratosphere, but the is so small that it is difficult to assign statistical significance to their effects on the ozone layer.

5. Nitrogen oxide, like certain chlorine-containing compounds, contributes to catalytic gas phase ozone depletion. The production of NO_x species from solid rocket motors is dominated by high temperature reactions known as "afterburning" in the exhaust plume. As the temperature of the exhaust decreases with increasing altitude, less NO_x is formed. In the *ait* case, the

first stage afterburning production of NO_x is nearly shut down before the vehicle reaches the stratosphere. The total NO_x deposited in the stratosphere is approximately 4 lbs from the first stage and less than 1 lb from the second stage. Diffusion and winds would disperse these quantities rapidly, therefore, no significant effect on ozone levels is expected from these emissions.

6. In summary, HC1, $A1_2O_3$ and NO_x emissions from *ait* test vehicle launches into the stratosphere would be insignificant because of the rapid dispersion predicted for such small quantities of substances. The small quantity of these compounds from the USAF *ait* program would not have a significant impact on stratospheric ozone.

4.2.2 CUMULATIVE IMPACTS

Due to the wind dispersion at Narrow Cape and the eventual gravitational settling of Al_2O_3, there would be no cumulative impacts to air resources associated with the two launches of the USAF *ait* test vehicle. Cumulative impacts to the upper atmosphere would be minimal in comparison to the impacts caused by other launch vehicles. Cumulative stratospheric loading of pollutants from the two USAF *ait* launches include approximately 2,526 lbs of Al_2O_3, 800 lbs of HCl, 1,112 lbs of a mixture of Cl and Cl_2, and 10 lbs of NO_x. These chemicals would be dispersed by the horizontal mixing process caused by the high velocity stratospheric winds. As a result, there would be no significant cumulative impacts to stratospheric ozone from the USAF *ait* program as compared with other past, present, or reasonable foreseeable future actions at KLC.

4.2.3 NO ACTION ALTERNATIVE

If the No Action alternative is selected, the USAF *ait* program would not take place at Kodiak Island. The potential impacts cited above would not occur as related to the proposed USAF *ait* program.

4.3 BIOLOGICAL RESOURCES

1. The FAA EA has been reviewed regarding potential impacts to the biological resources of Kodiak Island and environs in general, and the proposed KLC site in particular, the areas of concern relative to the proposed USAF *ait* test vehicle. The USAF adopts the analysis and conclusions of the FAA EA with regard to the potential impacts to biological resources from

site operations and vehicle launches, including the two proposed USAF *ait* launches. However, the recent listing of the Steller's eider and location of the USAF *ait* vehicle launch trajectory near Ugak Island where Steller sea lions haul out necessitate additional discussions. In accordance with Section 7 of the Endangered Species Act, the USAF is consulting with the USFWS on the Steller's eider and NMFS for the Steller sea lion to assure that the proposed USAF action is not likely to jeopardize the continued existence of the species or result in destruction or modification of the species habitat.

2. For a detailed description of potential impacts to other biological resources, the reader is referred to the FAA EA.

4.3.1 PROPOSED ACTION

4.3.1.1 Steller's Eider

1. Based on discussions with the USFWS, there is concern for potential impacts to Steller's eiders from onsite lighting at KLC. This concern is based on reports of strikes by Steller's eiders and other sea birds on unshielded lights of fishing vessels and at an airport radar facility during periods of "low weather" and fog. Bird strikes during stormy weather are also common to crabbing vessels in the Bering Sea (Balow, 1997).

2. Lighting at KLC will consist of low-level safety and security lighting on the exteriors of facilities at the site. Such lighting is typically downcast and shielded. Processing of the USAF *ait* test vehicle prior to launch will occur within an enclosed facility and therefore will not require exterior lighting. It is important to note that KLC facilities are sited some distance from the ocean. The nearest structure is the water pumphouse, about 600 meters (2,000 feet) from shore, while the Launch Pad is about 1,050 meters (3,500 feet) and the Launch Control and Management Center is about 1,800 meters (6,000 feet) from shore. Also, there is intervening topography and vegetation between KLC facilities and the shore. As a result of these factors, onsite lighting is not expected to attract seabirds, including the Steller's eider. Potential impacts related to onsite lighting are not expected to be significant.

3. As discussed in Section 4.4, launch noise is expected to be 95 dBA at the Launch Pad, attenuating to 90 dBA at a distance of approximately one mile. As stated in the FAA EA, noise levels of 80 dBA or greater are sufficient to startle birds. Steller's eiders that are wintering in the vicinity of the site may be affected. However, as the duration of launch noise

from the *ait* test vehicle is limited to approximately one minute, the Steller's eiders, like other birds, are expected to return to the area within minutes of the launch. Therefore, potential noise impacts to the Steller's eiders and other sea birds from the two proposed *ait* launches is not expected to be significant.

4. In the event of a major launch failure during approximately the first minute of flight of an *ait* test vehicle, debris could fall in the ocean off Narrow Cape. The debris would not fall in a concentrated pattern and the chance of hitting even a single sea bird sitting on the ocean surface is remote. However, the chance of a launch failure during the first minute of launch is also remote. Therefore, it is anticipated that Steller's eiders would not be significantly impacted in the unlikely event of catastrophic failure and subsequent debris scatter of the *ait* test vehicle over the Narrow Cape area.

4.3.1.2 Steller Sea Lion and Other Marine Mammals

1. Potential impacts to the Steller sea lion (*Eumetopias jubatus*) would be related to the launch trajectory of the USAF *ait* test vehicle, which will fly near Ugak Island immediately after lift-off (see Figure 4.5-1). It is estimated that approximately 300 Steller sea lions utilize Ugak Island as a haulout, but not a rookery, during the late summer and early fall postbreeding period (FAA EA, 1996; ENRI, 1997) (see Figure 4.4-1). As a result, potential impacts would not interfere directly with the breeding cycle of the species. Although the launch of the two USAF *ait* test vehicles is not expected to have a significant impact on the Steller sea lion, sea lions using the haulout area on the north shore of the Ugak Island may exhibit a startle response to the noise from the launch of the *ait* test vehicle.

2. As shown in Figure 4.5-1, the trajectory for the USAF *ait* test vehicle is approximately one mile from Ugak Island. As a result, the debris scatter from a potential major failure of the *ait* test vehicle would not impact Ugak Island. Therefore, a major failure of the launch of the *ait* test vehicle would not impact Steller sea lions or harbor seals hauled out on Ugak Island.

3. During the flight of the *ait* test vehicle, the expended first and second stage of the vehicle and the *ait* instrumentation package would impact in the Pacific Ocean. The expended first stage would impact in the ocean approximately 300 km downrange, and the expended second stage and instrumentation package would impact the ocean approximately 1,800 km downrange and approximately 300 km off the coast of southern Washington state. Depending on the season, these areas could be used by marine mammals, including migratory whales and pelagic

species. The chance of an expended stage or the instrumentation package hitting a marine mammal on the surface or near the surface of the ocean is remote. Therefore, it is anticipated that marine mammals, including migratory whales and pelagic species, in the open ocean would not be significantly impacted by the expended *ait* stages or instrumentation package as the splashdown in the water.

4. In the event of a major launch failure during the flight of an *ait* test vehicle, debris would fall in the ocean. Depending on the time of the failure, some debris could potentially fall in areas of the Pacific Ocean used by marine mammals, including migratory whales and pelagic species. The debris would not fall in a concentrated pattern and the chance of hitting a marine mammal on the surface or near the surface of the ocean is remote. Therefore, it is anticipated that marine mammals, including migratory whales and pelagic species, in the open ocean would not be significantly impacted in the event of a major launch failure and resulting debris scatter of an *ait* test vehicle.

4.3.1.3 Noise and Sonic Boom

1. Noise impacts associated with launch of the USAF *ait* test vehicle are addressed on a comprehensive basis in Section 4.4. Specific to Steller sea lions and harbor seals that utilize Ugak Island, noise from the USAF *ait* would not be significant. Launch noise from the USAF *ait* test vehicle will be approximately 85 A-weighted decibels (dBA) at Ugak Island. This noise would be of low frequency, short duration and likely near ambient levels, depending on wind and surf conditions. As a result, the impact to Steller sea lions and harbor seals hauled out on Ugak Island is not expected to be significant (Stewart, 1997).

2. As discussed in Section 4.4, a focused sonic boom is expected to occur during the ascent phase of the USAF *ait* test vehicle. Responses to a sonic boom depend on the intensity of the boom and biological chronology of the affected species (Stewart, 1997). The maximum focused boom at the surface from the *ait* launch would be 2.7 psf (a relatively low amplitude), about 40 nautical miles downrange from the launch pad and more than 35 miles from Ugak Island (see Figure 4.4-3). As a result, impacts to marine mammals on Ugak Island would not be significant.

3. The focused sonic boom from the ascent phase of the USAF *ait* test vehicle will occur in an area of the Pacific Ocean used by marine mammals, including migratory whales and pelagic species. The chance of a marine mammal being on or near the surface of the ocean in the

limited area affected by the focused sonic boom is remote. However, in the event a marine mammal is on the surface in the area, the impact would not be significant due to the relatively low amplitude of the sonic boom (Stewart, 1997).

4. The underwater pressure of the focus sonic boom from the *ait* ascent phase is expected to impact a water column ranging to a depth of about 100 meters and have an estimated pressure range of 0.01 pounds per square foot (psf) (equivalent to 120 decibels [dB]) to 2.0 psf (equivalent to 160 dB). It is known that, with marine mammals, a noise of 120 dB may result in behavioral effects and noise of 160 dB may cause some harm (Stewart, 1997). However, based on the short duration of this sonic boom (200 milliseconds [Cheng, 1997]) and on the limited impact area, these impacts are not expected to be significant.

5. As discussed in Section 4.4, a carpet boom with a maximum amplitude of 3.2 psf is expected to occur about 1,300 nautical miles downrange from the launch pad, during the descent phase of the USAF *ait* test vehicle (Figure 4.4-3). This noise event would not affect species on Ugak Island. As discussed above for the ascent phase focused sonic boom, the chance of a marine mammal being on or near the surface of the ocean in the limited area of the descent phase sonic boom is remote. However, in the event a marine mammal is on the surface in the area, the impact would not be significant due to the relatively low amplitude of the sonic boom (Stewart, 1997).

6. While little is known of the potential effects of exposure to impulse noise on marine mammals below the sea surface, the small USAF *ait* test vehicle would produce relatively small overpressures of the ascent and descent booms. As a result, any responses from marine mammals within a few tens of meters below the surface would likely be limited to brief startle responses and/or temporary shifts in auditory threshold. The locations and relatively small impact areas of the sonic booms would likely affect only a few individuals of marine mammals, and impacts would not be significant (Stewart, 1997).

7. The area of impact for the two focused booms and two carpet booms is relatively small. As a result, given the relatively small number of marine mammals, including migrating whales and pelagic species, that might be near the surface within either of the boom-impact zones at the time of impact, significant impacts are not expected.

4.3.2 CUMULATIVE IMPACTS

Cumulative impacts would not occur as a result of launching the two USAF *ait* test vehicles as compared with other past, present, or reasonable foreseeable future actions at the KLC. Potential impacts from a single launch are not expected to be significant. Due to the eight months between the two *ait* launches, cumulative impacts also would not be significant.

4.3.3 NO ACTION ALTERNATIVE

Under the No Action alternative the proposed two launches of the USAF *ait* test vehicle would not occur. Therefore, potential impacts to biological resources also would not occur.

4.4 NOISE

1. The FAA EA has been reviewed regarding noise impacts of construction and operation of the KLC site, the area potentially affected by the proposed processing and launch of the USAF *ait* test vehicle. The USAF adopts the analysis and conclusions in the FAA EA with regard to pre/postlaunch operations. Additionally, the USAF determined that a specific analysis of noise impacts related to launch of the *ait* test vehicle would be included in this USAF EA.

2. To address launch specific noise and sonic boom impacts associated with the USAF *ait* program, additional analyses were conducted, and the results are discussed below. The detailed noise analyses completed for the USAF *ait* program are included in Appendix C.

4.4.1 PROPOSED ACTION

4.4.1.1 <u>Launch Related Noise Impacts</u>

4.4.1.1.1 On-Pad Rocket Noise

1. On-pad rocket noise occurs when the vehicle engines are firing. While the noise levels from a launch are highest at the launch pad, on-pad noise levels away from the launch pad itself are typically much lower than in-flight noise levels because the sound source is low, and the sound waves move along the ground and tend to experience significant attenuation over long distances.

2. On-pad rocket noise levels for the launch of the USAF *ait* test vehicles are shown in Figure 4.4-1. As shown in Figure 4.4-1, noise levels for the USAF *ait* test vehicles are 95 dBA approximately 6,250 feet from the center of the pad, decreasing to 70 dBA at a distance of 5.6 to 15 miles from the launch pad. For a perspective on these noise levels,

Table 4.4-1 shows that 95 dBA is comparable to noise generated by a DC-9 aircraft as heard from a distance of 6,000 feet, and 70 dBA is comparable to the noise level from a heavy truck at a distance of 50 feet. Noise generated by the launch of the two USAF *ait* test vehicles will be present for approximately one minute. Noise from the launch of the two USAF *ait* test vehicles will not be significant due to the short duration of the noise event and low frequency of noise generated.

4.4.1.1.2 In-Flight Rocket Noise

1. In-flight rocket noise occurs when the vehicle is clear of the launch pad, and sound propagates from the vehicle to the ground without significant attenuation. The major sources of rocket noise are from interaction of the exhaust jet with the atmosphere, noise from the combustion chamber, and noise from the postburning of fuel-rich combustion products in the atmosphere. The emitted acoustic power from a rocket engine and the frequency spectrum of the noise can be calculated from the number, size and thrust, and flow characteristics of the engines. To evaluate the potential noise impact associated with launch and ascent, it is necessary to consider not only the overall sound level, but the frequency spectrum and duration of exposure.

2. Launch noise and ascent noise for the USAF *ait* test vehicle were computed using the RNOISE model recently developed for launch vehicle analysis (see Appendix C.1). Figure 4.4-2 shows the noise level contours for the USAF *ait* test vehicle during flight in the near-field. The maximum in-flight noise level (see Figure 4.4-2) is generally higher than the launch pad noise level, as shown in Figure 4.4-1. This is a direct result of the sound source (i.e., the vehicle) being aloft.

3. As shown in Figure 4.4-2, in-flight noise levels for the USAF *ait* test vehicle range from 90 dBA at a distance of approximately 9,000 feet from the launch pad, to 70 dBA at a distance of between 8.7 to 12.3 miles from the launch pad. Noise from launch of the USAF *ait* test vehicle will not be significant due to the noise levels generated and the short duration of time that they are present.

4.4.1.1.3 Sonic Boom

1. Sonic boom from launches occurs when the vehicle is at supersonic speeds and has pitched over sufficiently for the boom to propagate to the ground. The generation of ascent related

sonic boom from the USAF *ait* depends on vehicle geometry and the rocket exhaust plume size and drag. For the USAF sub-orbital *ait* test vehicle, there will also be a sonic boom during the descent phase the *ait* instrument package. Descent related sonic boom depends on the geometry of the reentry of the instrument package.

2. Sonic booms for the launch of the USAF *ait* test vehicle were computed using the PCBoom3 model (see Appendix C.1). Figure 4.4-3 shows the sonic boom footprints for the USAF *ait* sub-orbital test flights. There are two distinct footprints: a crescent shaped focal zone about 75 km (46 miles) south of the launch point associated with the ascent phase of the USAF *ait* test flight; and a concentrated carpet boom region at the splashdown point of the USAF *ait* instrument package approximately 1,800 km (approximately 1,130 miles) from the launch site and 300 km off the coast of southern Washington state. Both of these footprints occur over open ocean.

3. The ascent phase of the USAF *ait* test flight focal zone footprint has the characteristics of an ascent accelerated boom: a small, high amplitude focal zone at the leading edge, followed by a lower amplitude carpet boom. The maximum ascent phase focus boom amplitude at the water surface for the USAF *ait* test vehicle is 2.7 psf (see Appendix C.1). The trailing carpet boom from the ascent phase diminishes rapidly as the vehicle gains altitude.

4. The USAF *ait* descent phase carpet boom footprint surrounds the splashdown point of the instrumentation package. This type of footprint would be circular for a pure vertical descent. Because the USAF *ait* descent is at an angle, the footprint is distorted somewhat in the uptrack direction. The maximum sonic boom, generated when the vehicle is at an altitude of approximately 2,400 meters (approximately 7,875 feet) when the USAF *ait* instrumentation package is about to become subsonic, is about 3.2 psf at the water surface (see Appendix C.1).

5. The USAF *ait* test vehicle will generate focused sonic booms ranging from 2.7 psf to 3.2 psf at the water surface. This is comparable to military fighter aircraft which generate focused sonic booms up to 3.0 psf, with occasional focused booms that range from 5 to 10 psf. Therefore, the focused sonic booms from the *ait* test vehicle are similar to those generated by fighter aircraft (Plotkin, 1997).

6. As shown in Figure 4.4-3, both USAF *ait* sonic boom footprints (e.g., ascent and descent) are over water. The ascent sonic boom, with an overpressure of 2.7 psf, generates an

underwater noise level of approximately 160 dBA for 200 milliseconds which can travel to a depth of 100 meters below the ocean surface. This noise will attenuate to approximately 10 percent of its original 160 dBA at 100 meters and will be spread over a limited area (see Appendix C.2). The descent sonic boom generates an overpressure of 3.2 psf at the water surface for 200 milliseconds. It will affect an extremely small column of ocean, as the sound distribution across the boom pattern on the surface of the ocean will be concentrated in the center. Therefore, the impact will not be significant.

7. Based on the above, the USAF has concluded that, due to the extremely short duration of time in which both sonic booms take place, and the minimal areas they affect, the sonic booms generated by the two USAF *ait* test vehicles would not result in a significant impact.

4.4.2 CUMULATIVE IMPACTS

Two launches of the USAF *ait* test vehicle are proposed. These launches are scheduled eight months apart (July 1998 and March 1999), so they are effectively isolated events. The single event noise impacts discussed above represent the total impact. Therefore, since each launch presents no significant impact, the sum of both launches would not result in a cumulative impact as compared with other past, present, or reasonable foreseeable future actions at the KLC.

4.4.3 NO ACTION ALTERNATIVE

Under the No Action alternative, the USAF *ait* program would not occur. While the noise levels and sonic boom overpressures from the USAF *ait* program are not significant, these impacts would not occur under the No Action alternative.

4.5 HEALTH AND SAFETY

4.5.1 PROPOSED ACTION

4.5.1.1 Public Health and Safety

1. Missile components and support equipment for the USAF *ait* program will be transported by military aircraft to the Kodiak Airport and then on over-the-road trucks from the Kodiak Airport to KLC, where they will be placed in the Integration and Processing Facility until needed. The transport and handling of hazardous materials will be conducted in accordance with applicable DoD procedures and in accordance with applicable DoD explosives safety

standards. An appropriate explosive safety quantity distance will be established and maintained around facilities where the missile components are stored and handled (Robertson, 1997). Applicable regulations include, but are not limited to, the following:

- Aircraft Transport:
  - Mil-Std-1971 - Designing for Internal Aerial Delivery in a Fixed Wing Aircraft.
  - AFJM 24-204 - Preparing Hazardous Materials for Military Air Shipments.
- Roadway Transport:
  - Mil-Std-1366C - Transporting Criteria.
  - Mil-Std-1784 - Mobility Towed and Manually Propelled Support Equipment.
  - CFR Title 49, Part 213 - Code of Federal Regulations Packaging and Transportation of Hazardous Materials, Truck Safety Standards.
- Hazardous and Explosives:
  - NAVSEA OP 5, Volume 1, technical Manual for Ammunition and Explosive Ashore, Safety Regulation for Handling, Storage, Production, Renovation and Shipping
  - AFM 92-201 - Air Force Explosive Safety Standards.
  - AFTO 11A-1-47 - DoD Explosive Hazard Classification Procedures.
  - DoD 4145.26-M - DoD Contractors Safety Manual for Ammunition and Explosives.
  - DoD 6055.9 - DoD Ammunition and Explosives Safety Standards.

2. The *ait* rocket motors will be transported in a rocket motor semitrailer designed to protect them from damage in the event of an accident. Because the fuel and explosives are sensitive to heat, there is the potential for ignition of propellant in an accident. However, as these boosters are solid propellant, they are much more stable than liquids or hypergolic fuels. DoD has considerable experience with shipment of missiles and other sensitive components. Analysis of past experience has shown the following potential for an accident involving the transport vehicle:

- Air Transport: In 1987, the USAF reported that the accident rate for military cargo aircraft was 1×10^{-3} for every 1,000,000 aircraft miles flown. Based on this, there is a one in 1 million probability of accident for every 1,000 miles of missile air transport.
- Road Transport: Representative data from the National Highway Transportation Safety Administration show a major accident rate of 6×10^{-8} per truck mile, or a probability of one accident in 16,000 trips of 1,000 miles each (U.S. Army, 1995).

3. Only a small fraction of accidents involving a transport vehicle would potentially affect a missile system being transported, as specialized shipping containers are used to protect the shipment. Consequently, potential health and safety impacts from transporting missile components are not expected to be significant.

4. The assembly of missile components, accomplished within enclosed facilities at KLC, has the potential to affect worker health and safety but, due to the design of the facilities, not public health and safety. Assembly activities are considered routine and are conducted in accordance with established regulations and applicable DoD procedures. As a result, potential impacts to worker health and safety are not considered significant.

5. Prelaunch evacuations, clearances and road closures will be conducted to assure safety for workers and the public for both a normal launch and an aborted launch of the USAF *ait* test vehicle. The impacts of these closure activities are not considered to be significant. Prior to launch, in accordance with DoD range safety procedures, the range safety officer will be responsible for the planning and control of evacuation activities to assure the safety of all persons within the flight path of the USAF *ait* test vehicle. The safety exclusion zone for the launch of the USAF *ait* test vehicle is a radius of 3,500 feet, as shown in Figure 4.5-1. Evacuation includes establishing appropriate roadblocks at least four hours prior to launch activities, coordinating and assisting local authorities, and conducting appropriate ground and air surveillance sweeps to assure that all areas are evacuated in accordance with agreements between the U.S. Navy and state and federal agencies. Medical and fire response units will be permitted to pass through roadblocks in the performance of their duties, depending on time remaining prior to launch.

6. Personnel inside the launch hazard area would be limited to those considered mission essential, and would remain within facilities rated to provide adequate blast and debris protection and to which positive communications would be maintained at all times. Nonessential personnel would be evacuated to outside the impact limit line. Mission-essential personnel would be instructed in safety procedures and equipped with any necessary safety devices.

7. As a result of the above procedures, the potential for health and safety impacts associated with the USAF *ait* program is not considered to be significant for program personnel and the public. The population of Kodiak Island is well removed from KLC and the flight path of the USAF *ait* vehicle.

4.5.1.2 Range Safety

4.5.1.2.1 Prelaunch Activities

1. Although no new test range will be created as a result of the proposed action and there is no existing test range associated with the proposed action, standard range safety for the USAF *ait* program will be in accordance with procedures established for Sea Test Ranges at the Naval Air Warfare Center Weapons Division (NAWC), Point Mugu, California and the Pacific Missile Range Facility (U.S. Navy, 1997). NAWC has extensive experience in providing range safety support worldwide. These procedures provide for range surveillance, clearance and air traffic control. The U.S. Navy range safety officer will be responsible for implementing range safety plans and approvals.

2. The NAWC will establish ground hazard areas at the launch site area and areas over the ocean beyond where debris from an early flight termination may fall (early termination is not expected). Failure of a missile guidance system that would cause debris to fall outside the ground and launch hazard areas would be detected by the range safety officer, who would terminate the missile flight before it could cross the hazard area (Robertson, 1997). The range safety program includes redundant airborne command destruct systems aboard two Navy 2P-3D Orion aircraft that will permit in-flight tracking of the USAF *ait* test vehicle. The remote area safety aircraft will be used for real-time monitoring of missile performance and evaluation of flight termination criteria (U.S. Navy, 1997).

3. This NAWC-provided range clearance and surveillance will occur for three designated areas of potential impact:
   - Ground Hazard Area - Prior to launch, all personnel not designated as "essential" will be evacuated from the ground hazard area shown in Figure 4.5-1.
   - Flight Hazard Area-there will be every practical effort to keep this area clear of nonparticipating aircraft and ships by establishing warning and restricted areas, publishing notices to airmen and mariners and by maintaining close liaison and coordination with agencies controlling both air and surface traffic (U.S. Navy, 1993).
   - USAF *ait* Test Vehicle Impact Area-All intended impact areas and the applicable airspace above will be surveyed to assure that ships or aircraft are not in the vicinity at the proposed time of impact, as necessary (U.S. Navy, 1993).

4. Prelaunch hazardous operations will be conducted in accordance with established procedures that implement applicable DoD regulations. Prior to launch, positive control of hazardous areas will be established. Unauthorized entry into hazard areas will result in delay of the

operation until the "All Clear" signal has been reestablished. The USAF *ait* test vehicle will be launched only after all required safety evacuations have been accomplished, thereby assuring that no unauthorized personnel are present in any hazardous area.

4.5.1.2.2 Flight Activities

1. During missile flight operations, the potential impact zone includes the launch pad and surrounding area, and all locations along the flight corridor. The impact zone for public safety includes those areas within and adjacent to the site which are within a 3,500-foot radius of the launch pad. The public will be excluded well outside the potential impact zone.

2. The principal concerns are launch-site and in-flight malfunctions. A missile may malfunction on the launch pad or may deviate from its anticipated flight path after takeoff, requiring the flight to be terminated. Debris resulting from a launch-site malfunction can result in the scattering of missile debris anywhere within the launch hazard area, which would have been cleared of all nonessential individuals prior to the launch. Debris resulting from an in-flight malfunction would impact within the flight corridor footprint shown in Figure 4.5-1. Impacts would not be significant.

3. The USAF *ait* vehicle will have an in-flight termination system, capable of terminating thrust and/or aerodynamic lift, or destroying the missile throughout the entire powered portion of the flight. The NAWC will initiate flight termination action when:
   - Data indicate that the missile impact point will violate impact limit lines and impact outside the designated protected impact area.
   - Position of missile is unknown due to the loss of tracking data.
   - Vehicle has the potential to violate range safety impact limit lines.
   - Missile performance diminishes such that continuation of flight creates a safety hazard and loss of range safety control.

   Such system provides a mechanism so that impact limit lines would not be violated in the event of a malfunction during flight. Therefore, potential impacts would not be significant.

4.5.1.2.3 Post-Flight Activities

In the event of a flight termination, debris-recovery activities would be conducted in accordance with DoD regulations and would not pose an impact to public health and safety. Any mishap would be investigated in accordance with established USAF procedures (AFI 91-204).

4.5.2 CUMULATIVE IMPACTS

1. The two USAF *ait* launches require thorough health and safety planning at the earliest stages, and health and safety requirements are implemented during all phases of operation. As a result, potential health and safety hazards are avoided or reduced to extremely low probabilities. Cumulative impacts from the two USAF *ait* launches will not be significant as compared with other past, present, or reasonable foreseeable future actions at the KLC.

2. The two USAF *ait* launches require evacuation of the KLC area and closure of all access roads, assuring that the public would not be exposed to any health or safety hazards. Consequently no cumulative impacts to public health and safety are expected to occur.

4.5.3 NO ACTION ALTERNATIVE

Under the No Action alternative, there would be no impacts, as the two USAF *ait* launches would not occur.

4.6 HAZARDOUS MATERIALS AND WASTE

4.6.1 PROPOSED ACTION

4.6.1.1 Gas Phase Emissions

As discussed in Section 4.2, some potentially hazardous substances would be released from the solid rocket propellant during launch of the two USAF *ait* test vehicles. The primary gas phase hazardous substance released from the USAF *ait* test vehicle is HC1, with an instantaneous concentration below 0.5 ppm and a 60-minute mean concentration below 0.025 ppm. Peak concentrations are expected to occur at unpopulated locations downwind of the launch site. Exposure to these levels is not expected to be harmful to individuals. Other gas phase pollutant concentrations will be an order of magnitude smaller and would not be harmful to individuals. Therefore, impacts related to exposure to these substances would not be significant.

4.6.1.2 USAF *ait* Vehicle Components

1. Both motors for the *ait* test vehicle contain solid propellant, the constituents of which are itemized in the following:
   - First Stage (Class 1.3 Hazard Classification):
     - Ammonium Perchlorate
     - Aluminum
     - Polybutadiene (as binder)
   - Second Stage (Class 1.1 Hazard Classification):
     - Nitroglycerin
     - 2-Nitrodiphenylamine (2-NDPA)
     - Nitrocellulose
     - Cyclotetramethylenetetranitramine (HMX)
     - Aluminum
     - Ammonium Perchlorate
     - Resorcinol (1,3-Dihydroxybenzene)
     - Triacetin
     - Graphite

2. The potentially hazardous substances associated with the USAF *ait* test vehicle are contained within the various subassemblies and motors of the vehicle. Therefore, under nominal operating conditions, no hazardous materials are released before launch.

3. The *ait* first stage flight control mechanism, the thrust vector control system, begins the flight with 1.85 gallons of hydraulic fluid which is vented during flight, resulting in up to 90 percent of the fluid being used during the mission. The second stage flight control mechanism is a closed system which contains 0.06 gallon of hydraulic fluid. While in flight, the hydraulic fluid released from the first stage will be vaporized as a result of vehicular velocity and dissipated by stratospheric winds. The second stage hydraulic reservoir is expected to survive the splashdown intact. Over time, the container is expected to decompose, thus allowing the 0.06 gallon of hydraulic fluid to be released. Subsurface currents will cause rapid dispersion of this very small quantity to be spread over a large area; therefore, there would be no significant impact to marine mammal or fish species.

4. The first stage of the *ait* test vehicle may contain approximately 25 lbs of residual propellant at splashdown. The second stage may contain less than 1 lb of residual propellant at splashdown. In addition, the first stage will contain approximately 0.18 gallon of hydraulic fluid at splashdown, and the second stage will contain approximately 0.06 gallon at splashdown. Subsurface currents will cause rapid dispersion of these small quantities to be spread over a large area; therefore, there would be no significant impact to marine mammal or fish species.

5. There are seven batteries on board the *ait* test vehicle, one of which is composed of 600 milliliters (37 cubic inches) of water with a 33 percent concentration of potassium hydroxide (KOH). The other six batteries are composed of nickel and cadmium. The batteries are expected to survive the impact with the water and will decompose over time. Subsurface currents will cause rapid dispersion of materials released from the batteries; therefore, there would be no significant impact to marine mammal or fish species.

6. As discussed above, due to rapid dispersion of the small quantities of materials released in the ocean from the expanded first and second stages of the *ait* test vehicle and the *ait* instrumentation package, there would be no significant impact to marine mammal or fish species.

4.6.2 CUMULATIVE IMPACTS

The two USAF *ait* launches are planned for July 1998 and March 1999. Due to the approximate eight-month interval between the two launch events, cumulative impacts related to release of gas-phase emissions, and the release of residual materials from the expended stages of the *ait* test vehicles, would not be significant as compared with other past, present, or reasonable foreseeable future actions at the KLC.

4.6.3 NO ACTION ALTERNATIVE

Under the No Action alternative, the two launches of the USAF *ait* test vehicles would not occur. As a result, none of the impacts described would occur.

CHAPTER 5.0
MITIGATION MEASURES

5.0 MITIGATION MEASURES

5.1 GEOLOGY AND SOILS, WATER, LAND USE, SOCIOECONOMICS, RECREATION, VISUAL AND CULTURAL RESOURCES

The FAA EA has been reviewed regarding mitigations for potential impacts to Kodiak Island from the proposed processing and launch of the USAF *ait* test vehicle. The USAF adopts the analysis and conclusions of the FAA EA with regard to mitigation measures for geology and soils, water, land use, socioeconomics, recreation, and visual and cultural resources. The FAA EA is included as Attachment 1 to this USAF EA.

5.2 AIR QUALITY

Pre/postlaunch ground operations to support the USAF *ait* program at KLC, as executed by the USAF, are the same as those proposed by the AADC and do not substantially change the impacts as related to such activity. The USAF adopts the analysis and conclusions of the FAA EA with regard to mitigation measures associated with potential air quality impacts.

5.3 BIOLOGICAL RESOURCES

1. The FAA EA has been reviewed regarding mitigations for potential impacts to biological resources from the proposed processing and launch of the USAF *ait* test vehicle. The USAF adopts the analysis and conclusions of the FAA EA with regard to mitigation measures for biological resources.

2. Because of the recent listing of the Steller's eider as a federal threatened species, and specific characteristics of the USAF *ait* test vehicle trajectory near Ugak Island and potential impacts to the Steller sea lion, the USAF will participate in the mitigation monitoring program developed by FAA. In accordance with the Endangered Species Act, the USAF is conducting informal Section 7 consultation with the USFWS. The final mitigation measures for the Steller’s eider is being developed as part of this consultation.

3. The USAF will participate in monitoring programs established by FAA. For marine birds, which include the Steller's eider, monitoring includes surf-zone surveys from shore one day prior to launch and two to five days after each launch. Results of these surveys will be utilized to determine any changes in habitat-use patterns and whether there is evidence of site

abandonment following a launch event. In addition, for the two USAF *ait* test vehicle launches, the USAF proposes to monitor onsite facilities to document any evidence of birds striking lights, with particular attention to any light strikes by Steller's eiders.

5.4 NOISE

The FAA EA has been reviewed regarding mitigations for potential noise impacts from the proposed processing and launch of the USAF *ait* test vehicle. The USAF adopts the analysis and conclusions of the FAA EA in regard to mitigation measures associated with potential noise impacts. Therefore, no additional mitigation measures are provided in this document. The reader is referred to the FAA EA for a discussion of mitigation measures for noise.

5.5 HEALTH AND SAFETY

1. The USAF will participate in the AADC emergency response plan for the KLC, as described in the FAA EA. Additionally, USAF will confirm that the established AADC quantity distance zones and launch facility design criteria for the KLC are sufficient to meet USAF requirements.

2. Prior to launch, positive control of hazardous areas will be established. Unauthorized entry into hazard areas will result in delay of the operation until the "All Clear" signal has been reestablished. The USAF *ait* test vehicle will be launched after required safety evacuations have been accomplished, thereby assuring that no unauthorized personnel are present in any hazardous area. Because established NWCS range safety procedures described in Section 4.5 would reduce potential impacts to less than significant, no additional mitigation measures would be required.

5.6 HAZARDOUS MATERIALS AND WASTE

The FAA EA has been reviewed regarding mitigations for hazardous substances related to operation of KLC. The USAF adopts the analysis and conclusions of the FAA EA in regard to mitigation measures associated with potential hazardous materials and waste. Therefore, no additional mitigation measures are provided in this document. The reader is referred to the FAA EA for a discussion of mitigation measures for hazardous materials.

CHAPTER 6.0
INDIVIDUALS AND AGENCIES CONSULTED

6.0 INDIVIDUALS AND AGENCIES CONSULTED

1. The following individuals and agencies were consulted or provided information during preparation of this EA:

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       Western Regional Climate Center, Reno, Nevada
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       Alaska District, Anchorage, Alaska
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       Marion Magwood, Unit Coordinator
     - U.S. Fish and Wildlife Service
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7.0 LIST OF PREPARERS

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CHAPTER 8.0
REFERENCES AND RESOURCES

8.0 REFERENCES AND RESOURCES

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TABLES

TABLE 1.1

OPERATIONAL PERMITS AND APPROVALS FOR THE KODIAK LAUNCH COMPLEX

ACTIVITY	REQUIREMENT	BASIS	AUTHORITY	AGENCY	COMMENTS
Federal					
KLC[1] Operation	Environmental Review	Major Federal action affecting the environment.	• National Environmental Policy Act (42 USC 4321 et seq.) • 40 CFR 1500 et seq.	USAF	Environmental assessment preparation.
KLC Construction and Operation	Consultation	Potential impact to threatened and endangered species.	• Endangered Species Act Section 7 (16 USC 1536) • 50 CFR 402	U.S. Department of Interior, Fish and Wildlife Service U.S. Department of Commerce, National Marine Fisheries Service	Consultation initiated.
KLC Construction and Operation	Consultation	Potential impact to cultural resources.	• National Historic Preservation Act Section 106 (16 USC 470f) • 36 CFR 800	See comments	Requires consultation with State Historic Preservation Office. Consultation complete (negative determination).
KLC Construction and Operation	Certification	Potential to affect state water quality standards.	• Clean Water Act Section 401 (33 USC 1341)	Alaska Department of Environmental Conservation	Certification issued.
KLC Construction and Operation	Consistency Review	Activity within coastal area.	• Coastal Zone Management Act (AS[2] 46.40) • 6 AAC[3] 50, 80, and 85	Alaska Office of the Governor	Final consistency determination issued.
Water Withdrawal from East Twin Lake	Permit	Appropriation of state waters.	• AS 46.15.030 et seq. • 11 AAC 72	Alaska Department of Natural Resources, Division of Mining and Water Management	Permit issued.

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(1) KLC= Kodiak Launch Complex.
(2) AS = Alaska Statutes.
(3) AAC= Alaska Administrative Code.

TABLE 2.1

EXISTING DoD LAUNCH SITES

SITE	RADAR COVERAGE	NO OVERFLIGHT	LOGISTICS	WEATHER	WITHIN RANGE
Wake Island	Yes	Yes	Yes	Yes	**No**
Kauai (Barking Sands)	Yes	**No**	Yes	Yes	**No**
White Sands Missile Range	**No**	**No**	Yes	Yes	Yes
Eastern Test Range - Cape Canaveral AFS	**No**	**No**	Yes	Yes	**No**
Western Test Range - Vandenberg AF	**No**	Yes	Yes	Yes	N/A

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Bold = Indicates site fails to meet selection criteria.
N/A = Not applicable.

TABLE 2.2

ALTERNATIVE SITES IN ALASKA

SITE	RADAR COVERAGE	NO OVERFLIGHT	LOGISTICS	WEATHER	WITHIN RANGE
Poker Flats	Yes	**No**	Yes	Yes	**No**
Elmendorf AFB	Yes	**No**	Yes	Yes	Yes
Point Barrow	Yes	**No**	**No**	Yes	**No**
Adak Island	Yes	Yes	**No**	Yes	**No**
Kodiak Island - Narrow Cape	Yes	Yes	Yes	Yes	Yes

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Bold = Indicates site fails to meet selection criteria.

TABLE 4.4-1

SOUND LEVELS AND LOUDNESS OF ILLUSTRATIVE NOISES IN INDOOR AND OUTDOOR ENVIRONMENTS (A-Scale Weighted Sound Levels)

dB(A)	OVERALL LEVEL (Sound Pressure Level Approx. 0.0002 Microbar)	COMMUNITY (Outdoor)	HOME OR INDUSTRY	LOUDNESS (Human Judgment of Different Sound Levels)
130	UNCOMFORTABLY LOUD	Mil. Jet Aircraft Take-Off w/After-burner From Aircraft Carrier @ 50 Ft. (130)	Oxygen Torch (121)	120 dB(A) 32 Times as Loud
120 110		Turbo-Fan Aircraft @ Takeoff Power @ 200 Ft. (90)	Riveting Machine (110) Rock-N-Roll Band (108-114)	110 dB(A) 16 Times as Loud
100	VERY LOUD	Jet-Flyover @ 1,000 Ft. (103) Boeing 707.DC-8 @ 6,080 Ft. Before Landing (106) Bell J-2A Helicopter @ 100 Ft. (100)		100 dB(A) 8 Times as Loud
90		Power Mower (96) Boeing 737, DC-9 @ 6,080 Ft. Before Landing (97) Motorcycle @ 25 Ft. (90)	Newspaper Press (97)	90 dB(A) 4 Times as Loud
80		Car Wash @ 20 Ft. (89) Prop. Airplane Flyover @ 1,000 Ft. (88) Diesel Truck, 40 MPH @ 50 Ft. (84) Diesel Train, 45 MPH @ 100 Ft. (83)	Food Blender (88) Milling Machine (85) Garbage Disposal (80)	80 dB(A) 2 Times as Loud
70	MODERATELY LOUD	High Urban Ambient Sound (80) Passenger Car, 65 MPH @ 25 Ft. (77) Freeway @ 50 Ft. From Pavement Edge, 10:00 AM (76 + or - 6)	Living Room Music (76) TV-Audio, Vacuum Cleaner	70 dB(A)
60		Air Conditioning Unit @ 100 Ft. (60)	Cash Register @ 10 Ft. (65-70) Electric Typewriter @ 10 Ft. (64) Dishwasher (Rinse) @ 10 Ft. (60) Conversation (60)	60 dB(A) 1/2 as Loud
50	QUIET	Large-Transformers @ 100 Ft. (50)		50 dB(A) 1/4 as Loud
40		Bird Calls (44) Lower Limit Urban Ambient Sound (40)		40 dB(A) 1/8 as Loud
	JUST AUDIBLE	(dB[A] Scale Interrupted)		
10	THRESHOLD OF HEARING			

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Source: Reproduced from Melville C. Branch and R. Dale Beland, Outdoor Noise in the Metropolitan Environment. Published by the City of Los Angeles, 1970, p. 2.

FIGURES

APPENDIX A
PUBLIC SCOPING

TABLE A.1

ISSUES RAISED BY THE PUBLIC
USAF *ait* PROGRAM

NUMBER OF RESPONSES	ENVIRONMENTAL TOPIC
14	Risk to Wildlife and Marine Life
10	Impacts on Fishing Industry
9	Potential Accidents/Safety
5	Lack of Adequate Involvement by the Public
5	Noise/Sonic Booms
4	FAA EA is Inadequate
3	EIS is Required
2	Access to Local Beaches (Fossil Beach and Narrow Cape)
2	Use of Nuclear Materials in Future Rockets
2	Lack of Adequate Road System to Service KLC
2	Ozone Depletion
1	Lack of Comprehensive Demobilization of KLC in EA and Cleanup
	NONENVIRONMENTAL ISSUES RAISED
13	Waste of Taxpayers’ Money
2	New Jobs Created for Local Residents

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TABLE A.2

INDIVIDUALS, AGENCIES AND ORGANIZATIONS THAT PROVIDED SCOPING COMMENTS USAF *ait* PROGRAM

LETTERS		
Resource Development Council for Alaska, Inc Anchorage, AK 99503-2035	Colleen Nevin Kodiak, AK 99615	Richard & Molly MacIntosh Kodiak, AK 99615
Kodiak Chamber of Commerce Kodiak, AK 99615	Susan Payne Kodiak, AK 99615	Cliff Davidson Kodiak, AK 99615
GE Stockholders' Alliance Tucson, AZ 85713-6402	Don Johnson Kodiak, AK 99615	Stacey Marz Anchorage, AK 99516
Florida Coalition for Peace & Justice Gainesville, FL 32607	Pete Cummiskey Kodiak, AK 99615	Hans U. Tschersich, MD Kodiak, AK 99615
Margaret D. Short Kodiak, AK 99615	Carolyn Heitman Kodiak, AK 99615	Daniel M. Jessup Kodiak, AK 99615
Kodiak Electric Association Kodiak, AK 99615	William H. Bulen Kodiak, AK 99615	Jessie Campbell Kodiak, AK 99615
Maurice R. Johnson Kodiak, AK 99615	Alaska Pacific Seafoods Kodiak, AK 99615	Marion Stirrup Kodiak, AK 99615
Linda Himelbloom Kodiak, AK 99615	Governor Tony Knowles Juneau, AK 99811-0001	Michelle Johnson Kodiak, AK 99615
Roderick J. O'Connor Kodiak, AK 99615	Kodiak Vision Clinic Jerimah L. Myers, O.D. Kodiak, AK 99615	Janet L. Axell Kodiak, AK 99615
Lance Westing Kodiak, AK 99615	KONIAG Inc Anchorage AK 99503	Ann Vileisis & Tim Palmer Kelly, WY 83011
Randy Gilbert Chiniok, AK 99615	Kodiak Isalnad Borough Kodiak, AK 99615	Don Dunn Kodiak, AK 99615
Susan Baker Chiniak, AK 99615	Alice Knowles Kodiak, AK 99615	
FAXES		
Kodiak Inn Kodiak, AK 99615	Kathryn L. Kinnear 907-486-2260	Tina M. Friend 907-486-7720
Dianna Stauffer Kodiak, AK 99615	Pacific Alaska Forwarders, Inc. Seattle, WA 98124	Walter Sapp Kodiak Electric Association 907-486-7720
Greg Spalinger 907-486-8377	Kodiak Fishmeal Company Kodiak, AK 99615	
E-MAILS		
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APPENDIX B
AIR QUALITY

1. Computation of ait Solid Rocket Motor Atmospheric Emissions and Dispersion

The JANNAF Solid Propellant Rocket Motor Performance Prediction Computer Program (SPP), Version 6.0 was used to determine exit plane emissions from each ait solid rocket motor. The chemical composition within the motors is given in section 3.2, paragraphs 3 and 4 of the USAF EA. The industry standard SPP code models performance and chemistry from the combustion chamber to the nozzle exit plane of solid rocket motors. The chemical composition of the exhaust, determined with the SPP code was input to the Standardized Plume Flowfield Model (SPF3), Version 3.5, to model the post-exit-plane plume through the region of mixing and afterburning to several hundred meters downstream (i.e. the far-field). High temperature reactions which occur in the afterburning region can convert exit plane species to other compounds. For example, HCl is converted to Cl and Cl_2 in this region of the plume. NO_x can also be produced in this region from the entrainment of ambient atmospheric species under plume conditions. The extent of afterburning, and thus conversion of species decreases with increasing altitude and eventually shuts down.

The ait flight vehicle is comprised of modified versions of the 2nd and 3rd stages of the Minuteman II missile. The model calculations were performed using specifications of the Minuteman II motors (nozzle geometries, operating conditions, propellant compositions, and propellant mass flows) except that the nozzle of the ait 1st stage motor (SR-19 Minuteman 2nd stage motor derivative) was taken to have an area expansion ratio of 10:1. The model for the ait 2nd stage engine (the M57 Minuteman 3rd stage) employed a single equivalent nozzle for the actual cluster of four nozzles.

Altitudes from the ground up to 40 km were considered (i.e. up through the troposphere and stratosphere). At each altitude, the SPF3 plume model was run for the average thrust level of the appropriate motor (i.e. approximately 52,000 and 18,000 lbf for the 1st and 2nd stage motors respectively) to a distance downstream where afterburning ceased. At that point, the mass flows of relevant species were determined by integrating over a plane perpendicular to the plume axis. The mass flow of each species was then divided by the total mass flow from the motor at the nozzle exit plane. The resulting ratio is the species mass deposition rate relative to the total exit-plane propellant mass flow rate, which in the case of the 1st stage motor is 205 lbm/s at average thrust and in the case of the 2nd stage engine is 65 lbm/s at average thrust. The fractional mass flow for individual species are multiplied by the total mass flow rate to obtain quantities of any species emitted by the nozzle.

The thrust (and mass flow rate) for a solid-fuel rocket motor can be significantly time dependent, varying by as much as +- 20% over the course of the main burn. The modeled relative mass deposition rates, however are not expected to be a strong function of thrust over typical excursions.

1.1 Stratospheric Emissions

The output of the SPF3 Version 3.5 code was used to determine stratospheric emissions. For the 15 to 40 km altitude region of the stratosphere, quantities of substances deposited (HCl, Cl_2, Cl, Al_2O_3 and NO_X) were calculated by integrating the quantity of each species deposited (mass fraction x total mass deposited) over time. The trajectory for the ait flights is shown/described in Fig. 4.10-3 in Section 4.10 of the ait Environmental Assessment.

1.2 Ground-Level Emissions and Dispersion

Computer model calculations have been performed to estimate the hazardous chemical concentrations in the air after both normal launches and ground level aborts of the ait vehicle from the Kodiak Launch Complex. The primary model used for these calculations is REEDM (Rocket Exhaust and Effluent Diffusion Model) Version 7.07 (Ref. 6). This model is designed to take into account the fuel and oxidant load, as well as the local meteorology and terrain to predict pollutant concentrations as a function of time and distance after a launch event. The REEDM uses a chemical thermodynamic program (NASA Lewis Chemical Equilibrium CET 89) to estimate such quantities as peak temperature and cloud rise following an abort. For a normal launch, output data from the SPP and SPF3 models on the heat content and chemical composition of a motor plume are input into REEDM.

REEDM was developed originally in 1982 by the H.E. Cramer Company, Inc.; it was based on multilayer dispersion models developed at the NASA Marshall Space Flight Center, and originally intended for the Space Shuttle. It has been used by the Air Force for applications involving Delta, Atlas and Titan launches in the intervening years. REEDM is used by range safety officers as the basis of launch/no-launch determinations at CCAS and VAFB. Several versions have been developed; Version 7.07, used here, was developed by ACTA Inc., in 1995. The REEDM calculations provided here were performed by The Aerospace Corporation, El Segundo, CA.

In order to use REEDM for the current problem, a database needed to be developed for KLC and the ait vehicle. The previous EA for the Kodiak Launch Complex, indicated that the terrain feature having the greatest impact on dispersion is a mountain 610 m high, 5 km east of the launch site. This terrain data base used a 10 degree slope and assumed the remaining terrain was flat.

Figures 1-9 show the results of the REEDM predictions for nominal and abort situations for two meteorological cases and two launch dates. For the launch dates scheduled in March and in July, the winds used (from NOAA data for Kodiak) were 5.5 m/s and 3.45 m/s respectively, while the temperatures were 0.5 C and 12.4 C, respectively. A worst case wind, which is nearly calm out of the west was also characterized. An average of 1.75 m/s for the nearly calm winds was used. The worst case occurs 2% of the time throughout the year. The REEDM calculations indicate that HCl, Cl_2, CO, NO and Al_2O_3 are species of potential concern from the ait vehicles. However as shown in Fig. 1-9, the peak concentrations and worst case 60 minute exposures for each of these species is far below applicable human exposure standards. These are discussed in Section 4.8 of the ait Environmental Assessment.

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6. J. R. Bjorklund, "User's Manual for the REEDM Version 7 Computer Program, TR-90-157-01, April 1990, H. E. Cramer Company, Inc., Salt Lake City, UT and Randolph L. Nyman, REEDM Version 7.07 Prototype Software Description, TR-950314/69-02, September 1995, ACTA, Inc., Torrance, CA.

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APPENDIX C
LAUNCH NOISE AND SONIC BOOM

APPENDIX C.1
NOISE METHODS OF ANALYSIS

NOISE METHODS OF ANALYSIS

1.0 NOISE DESCRIPTORS AND EFFECTS

Noise is generally described as unwanted sound. Unwanted sound can be based on objective effects (hearing loss, damage to structures, etc.) or subjective judgments (community annoyance). Noise analysis thus requires a combination of physical measurement of sound with psycho- and socioacoustic effects.

Launch vehicles generate two types of sound. One is engine noise, which is continuous sound. The other is sonic booms, which are transient impulsive sounds. These are quantified in different ways.

1.1 DESCRIPTORS OF CONTINUOUS SOUNDS

Measurement and perception of sound involves two basic physical characteristics: amplitude and frequency. Amplitude is a measure of the strength of the sound and is directly measured in terms of the pressure of a sound wave. Because sound pressure varies in time, various types of pressure averages are usually used. Frequency, commonly perceived as pitch, is the number of times per second the sound causes air molecules to oscillate. Frequency is measured in units of cycles per second, or Hertz (Hz).

Amplitude. The loudest sounds the human ear can comfortably hear have acoustic energy one trillion times the acoustic energy of sounds the ear can barely detect. Because of this vast range, attempts to represent sound amplitude by pressure are generally unwieldy. Sound is therefore usually represented on a logarithmic scale with a unit called the decibel (dB). Sound on the decibel scale is referred to as a sound level. The threshold of human hearing is approximately 0 dB, and the threshold of discomfort or pain is around 120 dB.

The difference in dB between two sounds represents the ratio of those two sounds. Because human senses tend to be proportional (i.e., detect whether one sound is twice as big as another) rather than absolute (i.e., detect whether one sound is a given number of pressure units bigger than another), the decibel scale tends to correlate linearly with human response.

Frequency. The normal human ear can hear frequencies from about 20 Hz to about 15,000 or 20,000 Hz. It is most sensitive to sounds in the 1,000 to 4,000 Hz range. When measuring community response to noise, it is common to adjust the frequency content of the measured sound to correspond to the frequency sensitivity of the human ear. This adjustment is called A-weighting (American National Standards Institute, 1988). Sound levels that have been so adjusted are referred to as A-weighted sound levels. The amplitude of A-weighted sound levels is measured in dB. It is common for some noise analysts to denote the unit of A-weighted sounds by dBA or dB(A). As long as the use of A-weighting is understood, there is no difference between dB, dBA or dB(A). It is only important that the use of A-weighting be made clear. It is common to use the term A-weighted sound pressure level (AWSPL) to refer to A-weighted sounds.

For analysis of damage to structures by sound, it is common not to apply any frequency weighting. Such overall sound levels are measured in dB and are often referred to as overall sound pressure levels (OASPL or OSPL).

C-weighting (American National Standards Institute, 1988) is sometimes applied to sound. This is a frequency weighting that is flat over the range of human hearing (about 20 Hz to 20,000 Hz) and rolls off above and below that range. C-weighted sound levels are often used for analysis of high-amplitude impulsive noise, where adverse impact is influenced by rattle of buildings.

Time Averaging. Sound pressure of a continuous sound varies greatly with time, so it is customary to deal with sound levels that represent averages over time. Levels presented as instantaneous (i.e., as might be read from the dial of a sound level meter), are based on averages of sound energy over either 1/8 second (fast) or one second (slow). The formal definitions of fast and slow levels are somewhat complex, with details that are important to the makers and users of instrumentation. They may, however, be thought of as levels corresponding to the root-mean-square sound pressure measured over the 1/8-second or 1-second periods.

The most common uses of the fast or slow sound level in environmental analysis is in the discussion of the maximum sound level that occurs from the action, and in discussions of typical sound levels. Figure A-1 is a chart of sound levels from typical sounds.

Assessment of cumulative noise impact requires average levels over periods longer than just the fast or slow times. The sound exposure level (SEL) sums the total sound energy over a noise event. Mathematically, the mean square sound pressure is computed over the duration of the event, then multiplied by the duration in seconds, and the resultant product is turned into a sound level. SEL is sometimes described as the level which, occurring for one second, would have the same sound energy as the actual event.

Note that SEL is a composite metric that combines both the amplitude of a sound and its duration. It is a better measure of noise impact than the maximum sound level alone, since it accounts for duration. Long sounds are more intrusive than short sounds of equal level, and it has been well established that SEL provides a good measure of this effect.

SEL can be computed for A- or C-weighted levels, and the results denoted ASEL or CSEL. It can also be computed for unweighted (overall) sound levels, with a corresponding designation.

For longer periods of time, total sound is represented by the equivalent continuous sound pressure level (L_{eq}). L_{eq} is the average sound level over some time period (often an hour or a day, but any explicit time span can be specified), with the averaging being done on the same energy basis as used for SEL. SEL and L_{eq} are closely related, differing by (a) whether they are applied over a specific time period or over an event, and (b) whether the duration of the event is included or divided out.

Just as SEL has proven to be a good measure of the noise impact of a single event, L_{eq} has been established to be a good measure of the impact of a series of events during a given time period. Also, while L_{eq} is defined as an average, it is effectively a sum over that time period and is thus a measure of the cumulative impact of noise.

Noise tends to be more intrusive at night than during the day. This effect is accounted for by applying a 10-dB penalty to events that occur after 10 PM and before 7 AM. If L_{eq} is computed over a 24-hour period with this nighttime penalty applied, the result is the day-night average sound level (L_{dn} or DNL). L_{dn} is the community noise metric recommended by the U.S. Environmental Protection Agency (U.S. Environmental Protection Agency, 1972) and has been adopted by most federal agencies (Federal Interagency Committee on Noise, 1992). It has been well established that L_{dn} correlates well with community response to noise (Schultz, 1978; Finegold et al., 1994).

The state of California quantifies noise by Community Noise Exposure Level (CNEL). This metric is similar to L_{dn} except that a penalty of 5 dB is applied to sounds in the evening, after 7:00 p.m. and before 10:00 p.m.

It was noted earlier that, for impulsive sounds, C-weighting is more appropriate than A-weighting. The day-night average sound level can be computed for C-weighted noise, and is denoted L_{Cdn} or CDNL. This procedure has been standardized, and impact interpretive criteria similar to those for L_{dn} have been developed (CHABA, 1981).

1.2 DESCRIPTORS OF SONIC BOOMS

Figure A-2 shows time histories (pressure versus time) for the two types of sonic boom signatures generated by launch vehicles: N-wave carpet booms and U-wave focus booms. Each consists of a pair of shock waves connected by a linear expansion (N-wave) or a U-shaped curve (U-wave). Each type of boom is well described by its peak overpressure in pounds per square foot (psf), and its duration in milliseconds (msec). Duration tends to have a minor effect on impact, so the peak pressure is all that is normally required.

For assessment of impact via L_{Cdn} as discussed in Section 1.0, the peak pressure is related in a simple way to CSEL, from which L_{Cdn} can be constructed. The peak pressure P (psf) is converted to the peak level (L_{pk}) dB by the relation

$$L_{pk} = 127.6 + 20 \log_{10} P \qquad \text{(A-1)}$$

CSEL is then given by Plotkin (1993):

$$CSEL = L_{pk} - 26 \qquad \text{(N-wave)} \qquad \text{(A-2)}$$

$$CSEL = L_{pk} - 29 \qquad \text{(U-wave)} \qquad \text{(A-3)}$$

2.0 NOISE EFFECTS

2.1 ANNOYANCE

Studies of community annoyance to numerous types of environmental noise show that L_{dn} is the best measure of impact. Schultz (1978) showed a consistent relationship between L_{dn} and annoyance. This relationship, referred to as the “Schultz curve”, has been reaffirmed and updated over the years (Fidell et al., 1991; Finegold et al., 1994). Figure A-3 shows the current version of the Schultz curve.

Some time ago L_{dn} of 55 dB or less had been identified as a threshold below which adverse impacts to noise are not expected (U.S. Environmental Protection Agency, 1972). It can be seen from Figure A-3 that this is a region where a small percentage of people are highly annoyed. L_{dn} of 65 dB is widely accepted as a level above which some adverse impact should be expected (Federal Interagency Committee on Noise, 1992), and it is seen from Figure A-3 that about 15 percent of people are highly annoyed at that level.

A limitation of the Schultz curve is that it is based on long-term exposure to noise. The proposed action is for a single launch. Therefore, analysis in the current study examines this on a single-event basis.

2.2 SPEECH INTERFERENCE

Conversational speech is in the 60 to 65 dB range, and interference with this can occur when noise enters or exceeds this range. Speech interference is one of the primary causes of annoyance. The Schultz curve incorporates the aggregate effect of speech interference on noise impact.

Because only one launch is planned, and noise would last for only a few minutes, speech interference is not expected to be a significant impact.

2.3 SLEEP INTERFERENCE

Sleep interference is commonly believed to be a significant noise impact. The 10-dB nighttime penalty in L_{dn} is based primarily on sleep interference. Recent studies, however, show that sleep interference is much less than had been previously believed (Pearsons et al., 1989; Ollerhead, 1992).

Traditional studies of sleep disturbance indicate that interference can occur at levels as low as 45 dB. Data indicates that at indoor SEL of 70 dB, about 20 percent of people will awaken (Federal Interagency Committee on Noise, 1992). Assuming a nominal outdoor-to-indoor noise reduction of 20 dB, these correspond to outdoor sound exposure levels of 65 dB and 90 dB, respectively. Note that the awakening threshold is comparable to the threshold of outdoor speech interference.

2.4 TASK INTERFERENCE

Due to startle effects, some task interference may occur to sonic booms. High levels of rocket noise may cause some task interference close to the launch sites. It is difficult to estimate degrees of task interference, since this is highly dependent on specific tasks. Startle from sonic booms is often stated as a concern, but there are no credible reported incidents of harm from sonic boom startle. Task interference from rocket noise is expected to occur at higher levels than speech interference.

2.5 HEARING LOSS

Federal OSHA guidelines (Title 29 CFR 1910.95) specify maximum noise levels to which workers may be exposed on a regular basis without hearing protection. Pertinent limits are a maximum of 115 dBA for up to 15 minutes per day, and unweighted impulsive noise of up to 140 dB. Exceeding these levels on a daily basis over a working career is likely to lead to hearing impairment. These levels are conservative for evaluating potential adverse effects from occasional noise events.

2.6 HEALTH

Nonauditory effects of long-term noise exposure, where noise may act as a risk factor, have never been found at levels below federal guidelines to protect against hearing loss. Most studies attempting to clarify such health effects found that noise exposure levels established for hearing protection will also protect against nonauditory health effects (von Gierke, 1990). There are some studies in the literature that claim adverse effects at lower levels, but these results have generally not been reproducible.

2.7 STRUCTURES

2.7.1 Launch Noise

Damage to buildings and structures from noise is generally caused by low-frequency sounds. The probability of structural damage claims has been found to be proportional to the intensity of the low-frequency sound. Damage claim experience (Guest and Sloane, 1972) suggests one claim in 10,000 households is expected at a level of 103 dB, one in 1,000 households at 111 dB, and one in 100 households at 119 dB.

Figure A-4 shows criteria for damage to residential structures (Sutherland, 1968), and compares them to launch noise spectra that could occur a few kilometers from the launch point of a medium (300,000 to 500,000 pound thrust) rocket. These data show that noise-induced damage to off-base property would typically be very minimal.

2.7.2 Sonic Boom

Sonic booms are commonly associated with structural damage. Most damage claims are for brittle objects, such as glass and plaster. Table A-1 summarizes the threshold of damage that might be expected at various overpressures. There is a large degree of variability in damage experience, and much damage depends on the pre-existing condition of a structure. Breakage data for glass, for example, spans a range of two to three orders of magnitude at a given overpressure. While glass can suffer damage at low overpressures, as shown in Table A-1, laboratory tests glass (White, 1972) have shown that-properly installed window glass will not break at overpressure below 10 psf, even when subjected to repeated booms.

The maximum sonic boom overpressures for the proposed launch will be 2.7 psf during launch (maximum focus boom) and 3.2 psf during entry, near the water impact point. These are well below the threshold where structural damage would be expected, were there structures in the vicinity.

3.0 NOISE MODELING

3.1 LAUNCH NOISE

On-pad and in-flight rocket noise was computed using the RNOISE model (Plotkin et al., 1997). Rocket noise prediction via this model consists of the following elements:

1. The total sound power output, spectral content and directivity is based on the in-flight noise model of Sutherland (1993). Noise emission is a function of thrust, nozzle exit gas velocity, nozzle exit diameter, and exhaust gas properties.

2. Propagation from the vehicle to the ground accounts for Doppler shift, absorption of sound by the atmosphere (American National Standards Institute, 1978), inverse square law spreading, and attenuation of sound by the ground (Chien and Soroka, 1980). A semi-hard ground surface (1,000 mks rayls) was assumed.

3. One-third spectral levels were computed at the ground, for every flight trajectory point, on a grid of 3721 points. ASEL and maximum A-weighted and overall sound levels were then derived from the results at each grid point.

The computed noise levels were then depicted as contours of equal level.

3.2 SONIC BOOM

Sonic boom was computed using the U.S. Air Force's PCBoom3 software (Plotkin, 1996). This is a full ray tracing model. Details of sonic boom theory are presented by Plotkin (1989) and Maglieri and Plotkin (1991). The specific approach to sonic boom modeling included the following elements:

1. Trajectories provided by the vehicle manufacturers were converted into PCBoom3 TRJ format using PCBoom3's TRAJ2TRJ utility. This utility generated required higher derivatives, as well as converting file formats.

2. Vehicle F-functions were calculated using the method of Carlson (1978). Area distributions were obtained from vehicle drawings. The shape factors computed were used to obtain nominal N-wave F-functions.

3. The F-function associated with the plume was obtained by a combination of the Universal Plume Model (Jarvinen and Hill, 1970) and Tiegerman's (1975) hypersonic boom theory.

4. Ray tracing and signature evolution were computed by integration of the eiconal and Thomas's (1972) wave parameter method.

5. Focal zones were detected from the ray geometry, and focus signatures computed by applying Gill and Seebass's (1975) numerical solution.

The resultant sonic boom calculations were depicted as contours of constant overpressure (psf).

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Table A-1. Possible Damage to Structures From Sonic Booms

Sonic Boom Overpressure Nominal (psf)	Type of Damage	Item Affected
0.5 - 2	Cracks in plaster	Fine; extension of existing; more in ceilings; over door frames; between some plaster boards.
	Cracks in glass	Rarely shattered; either partial or extension of existing.
	Damage to roof	Slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole.
	Damage to outside walls	Existing cracks in stucco extended.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass, e.g., large goblets, can fall and break.
	Other	Dust falls in chimneys.
2 - 4	Glass, plaster, roofs, ceilings	Failures show that would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition.
4 - 10	Glass	Regular failures within a population of well-installed glass; industrial as well as domestic greenhouses.
	Plaster	Partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Roofs	High probability rate of failure in nominally good state, slurry-wash; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Walls (out)	Old, free standing, in fairly good condition can collapse.
	Walls (in)	Inside ("Party") walls known to move at 10 psf.
Greater than 10	Glass	Some good glass will fail regularly to sonic booms from the same direction. Glass with existing faults could shatter and fly. Large window frames move.
	Plaster	Most plaster affected.
	Ceilings	Plaster boards displaced by nail popping.
	Roofs	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gale-end and will-plate cracks; domestic chimneys dislodged if not in good condition.
	Walls	Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Bric-a-brac	Some nominally secure items can fall; e.g., large pictures, especially if fixed to party walls.

Source: Haber and Nakaki, 1989

APPENDIX C.2
MODEL ANALYSIS OF SONIC-BOOM NOISE PENETRATION UNDERWATER

Results and Discussion of Submarine Sonic Boom Noise Penetration Analysis

Remarks on input data and model analysis

The input data in the analysis for the Kodiak program, was furnished by Dr. K. Plotkin, Wyle laboratory, based on scaling laws deduced from an earlier work by Jarviner and Hill [1] for underexpanded rocket plumes. The shape of the exhaust plume was determined up to a downstream station where the Mach disc is located. Together with the known vehicle geometry, this suffices to arrive at the F-function needed for the ray/geometrical acoustic calculation, from which the incident waveform and intensity at the sea level were obtained. Figure 1 illustrates schematically the plume and the Mach disc downstream of the rocket and the corresponding F-function distribution. The overpressure data at the sea level contributed by the omitted plume portion was not available.

Although the contribution from the rear portion of the plume is relatively weak and has little significance for most predictions/measurements on the ground, its effects on noise penetration under water may not be negligible, inasmuch as the plume can not only add considerably to the signature length, of the waveform, say L', but may alter the far-field attenuation rate (owing to an unbalanced [total] impulse which is normally zero). Therefore, in addition to the analysis made according to the two sets of sea-level overpressure furnished, three more sets of sea-level overpressure will be considered in order to access the correct real-plume effects.

While the plume effect should generally be regarded a significant aspect of the submarine problem for most space-launch program, the Kodiak program at hand may be expected as an exception. This is because the smallness of the rocket's weight, thrust, and dimension make its hydroacoustic impact very minute in comparison with that found with the Apollo or Atlas launch (which we have examined earlier). (The rocket thrust delivered at the Minute-Man launch amounts only to about 1% of that for the Apollo.)

The sound-pressure intensity underwater at the level of 160 db has been considered potentially harmful to some marine mammal species [2,3].* This would amount to about two (2) psf.** On the other hand, intensity at the 120-130 db corresponding to (rms) overpressure in the percentile (0.01) psf range, may also affect adversely the behavior and activity patterns of some fish and mammals. These are believed to be factors in the recent impact assessment on the program of ocean wave guide (SOFAR) experiments [3,4,5]. Whereas, the following model analyses will confirm that the sonic-boom noise generated in the present program cannot reach well down to the 1 km depth of the SOFAR channel, an overpressure level at the 0.01-2 psf range does occur at depth of 0-100 meters, according to the following analysis.

In passing, we note that the 10^{-2} psf level mentioned and to be seen below is still well above the 10^{-1} Pa, or 0.0021 psf, which has been taken to be the back-ground noise level of the sea in many studies, according to Ref [6]. Also note that acoustic disturbances in the 10-500 Hz frequency range, as well as in the higher 10-30 kHz have been of concern in studies with certain whale species [7].*** The acoustic signals in the higher range mentioned was of considered essential in previous investigations, on account of their relatively short propagation range, being 10 km or

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* Presumably, it causes a prolonged period of the hearing-threshold shift.

** "psf" stands for pounds per square foot.

*** The 10-500 Hz signals are believed to affect mostly Baleen whales, while the 10-30 kHz may potentially affect the smaller mammal species. I am grateful to Dr. Bruce Howe, Wash. Univ., Seattle, Wash. for helpful discussions.

less, owing to a chemical absorption process according to an existing study [7]. But this 10 km range is by no means short for noise penetration study here.

The results discussed below pertain mainly to the analysis based on the *flat-ocean* model, in which the critical dependence on the rocket-size and its plume effects will become clearly evident. The two sets of the available sea-level overpressure data are limited however to a condition corresponding to a wavefield moving over the (ocean) surface at nearly the *sonic* speed which is comparable to that in a superboom. Under this condition, a solution allowing interaction with a wavy (ground/ocean) surface is yet to be developed. For this reason, the corresponding wavefield computations *under* a wavy ocean has not been performed. As indicated in an earlier elucidation, this interaction effects will be significant even for incident waves corresponding to a "carpet boom" normally found in steady supersonic cruise. Its importance will nevertheless be discussed on the basis of an example analyzed earlier at a condition removed from that of a super/focused boom.

Submarine Sonic-Boom Wavefields Under a Flat Ocean

Two incident sonic-boom wave forms at the sea level furnished by the Wyle Laboratory, together with three of their variants, are employed as input surface overpressure data for calculating five cases of hydroacoustic response in a flat-ocean model. The sea-level overpressure in the first example was obtained (directly) from the geometrical acoustic calculation of the PC Boom program, referred to as the "carpet boom." Its distribution is shown as solid curve at the top left of Fig. 2 for z=o corresponding to the sea level. Inspite of the presence of *three* discontinuities in the F-function [Fig.1(b)], the waveform arriving at the sea level takes on nearly N-wave form. The example with this input waveform will be designated to be Case A. For the second example, to be referred as Case B, the incident waveform at the sea level was provided by another version of the PC Boom involving a *local* modification of the geometrical acoustic program by adopting partly the Gill-Seebass model solution to the Tricomi equation. This is the "focal-boom model" proposed and implemented successfully by Plotkin in Ref. [8]. The resulting overpressure at the sea level is shown in dashes also on the top left of Fig. 2 for Z = 0. The rabbit-ear like spikes near the two ends of the profile in dashes has been known to be characteristic of waveform from the Gill-Seebass model as well as several sonic-boom measurements recorded from towers (above the ground level). The overpressure at each streamwise location are shown as "dP" (in psf) vs. "x" (in feet) at six successive depth levels in Fig. 2, corresponding to distances from the surface Z = 0, 10, 50, 100, 300 and 1,000 feet. Both set of results show that the disturbance magnitude as well as its manner of attenuation are not much different from those found in submarine response to aircraft-generated sonic booms [9,10].

We next examine the importance of, and the need for, a more complete description of the F- function corresponding to the aft portion of the rocket plume. We consider three plume extension models, postulating in two of these cases the similarity between the anticipated Kodiak/Minute-Man waveform and that of the much larger Apollo/Atlas system in the length scales of the negative to positive portions of the waveform (at sea level). The latter scale ratio is found to be approximately nine to one (9:1) [11]. The sea-level overpressure are shown on the upper left of Fig. 3 for three examples, Cases C, D and E, labeled, respectively, in thin solid curve, in dashes, and in dash-dot curve. They model the plume extension by the addition after the real shock of Case A (shown in heavy full dots) a linear axial variation, as depicted. Case C (in thin solid line) has a shorter plume extension, the length of which is determined by requiring the positive and negative areas to balance with each other. The remaining Cases D and E have the same plume extension length called for by the 9:1 ratio. In Case D, the area on the negative portion is 1.8 time that in the positive portion, while in Case E with a greater negative overpressure contribution, the corresponding area ratio is 2.7. As were the data from the Apollo records during ascent, the longer tail portions of Cases D and E give a nonvanishing sink effect in the farfield, noticeable at the larger depths. These results confirm that, even without accounting for the full length of the real plume, the overpressure in the range of 0.01 to 2 (mentioned earlier) can be found within a depth of 1,000 ft., or about one *third* of a *kilometer*. In Cases D and E, disturbances at depth of 300 ft. (close to 100 meters) of the order up to 0.10 and 0.20 psf are predicted even at 1,000 ft. or 1/3 km, below sea level.

The above study based on the flat-ocean model confirms that under the flight track, the sonic-boom disturbances produced by the Kodiak Minute-Man model can penetrate under water with overpressure level comparable to 1 psf at 100 ft. depth and 0.1 psf at depth as large as 1,000 ft. Unlike the much larger Apollo, Titan or Atlas Launch vehicles, however, the Minute-Man shot is not expected to produce acoustic disturbances/noise that can noticeably reach down to the ocean wave guide in most part of the globe.

Surface Waviness Influence

In the absence of a more appropriate analysis to establish the importance of the sonic boom and surface wave interaction effect on the superboom-like domain (which would call for solving a time-dependent, nonlinear version of the Tricomi equation with a wavy wall boundary), we shall examine the result of a *linear* system valid for a wavefield (horizontal) propagation velocity larger than the sea-level sound speed analyzed earlier in Ref. [10]. The work therein sought correction for a flat-ocean response to an incident N-Wave, based the theory explained earlier. The particular example given was for a *subsonic* (wavefield) Mach number under water $M_W = 0.402$, corresponding to a supersonic cruise Mach number $M_o = 2.1$ at the Stratosphere and a sea level Mach number $M_A = 1.8207$. The maximum overpressure at the sea level is 2.020 psf in this case. The wave length of the sinusoidal surface-wave train considered in this example is comparable to the incident sonic-boom signature length L', being $4L'/2\pi \approx 261.4$ ft. The maximum surface slope is taken to be $\delta = 0.1$. The root-mean-square values (rms) of resulting overpressure distributions (with the waviness corrections) are shown in Fig. 4 as solid curves at three depth levels Z = 100, 200 and 300 ft. The difference from the uncorrected overpressure in the flat-ocean model (included as dashes) are significant as depth increases. At Z = 300 ft. depth and beyond, the waviness correction becomes an effect of the first-order importance, altering the nature and power of the noise penetration under water.

For incident superboom-like wavefields comparable to those considered earlier in Case A-E for the flat-ocean model (Figs. 2,3), the linear theory yields unbounded results and is invalid. Nevertheless, the important role of the surface waviness influence in the corresponding nonlinear, elliptic-hyperbolic mixed problem should be convincingly evident from above.

Impact-Zone 3-D Description

The lateral (horizontal) extent of the impact zone is typically large compared to its windward/streamwise dimension (even at the leading edge of the boom carpet identified with the super/focused boom (refer to Fig. 5). A *high aspect-ratio* theory similar to the lifting-line theory in aerodynamics is therefore applicable and was demonstrated to work well in Ref. [11]. The theory reduces the problem to a *two* dimensional one and thus justifies the 2-D formulations underlying all the foregoing analyses. Essential is, however, the proper orientation of the local coordinates so that the 2-D analysis is carried out for each span station in a *plane normal* to the (curved) center line. By this procedure, contour plots for specified/chosen psf value of the overpressure may be generated for each depth level, using data from the 2-D analysis. [This plot has not yet been prepared for this presentation.]

Descent Boom Impact

The sonic booms generated along most part of the descent trajectory of the Kodiak plan will propagate along rays which may reach the ground/sea surface *far* from the *target area* sea/ground surface with much attenuated signals, or can never do so due to refraction. Significant sonic boom impact occurs, however, near the very end of the descent phase when the vehicle/missile is decelerated to low supersonic or subsonic speed, resulting from bow shock detachment. With the exception of a vertical (downward) trajectory, a location can always be found in this instance on the propagating paraboloid-like, detached shock/wave front where the surface slope is parallel to sea/ground surface. Therefore, it should not be surprising to find the front of the descent boom hitting the sea/ground surface at nearly normal incidence, and this is indeed the case found by the ray-acoustic (PC Boom) computation for the Kodiak run.

The calculation by K. Plotkin indicates a ray-angle (measured from the vertical) closes to 6.5°. The speed of the horizontal wave-field movement may then be estimated to be the product of *cot* (6.5°) and the sea-level sound speed corresponding to a Mach number of 8.78 above the water. This gives a Mach number 1.94 under the water, that is, during a short period at and after the impact, the responding hydroacoustic wavefield will move *supersonically* under the ocean. This means that, unlike the case with ascent phase, signals will propagation with *undiminished* strength to a depth considered larger than the signal wave length, L', which will be eventually attenuated, however, by 3-D effects.

The foregoing properties of the supersonic under water wavefield would have been an extremely important aspect of the present study, if not for the other features shown in the descent-boom "foot print" according to Plotkin's analysis (Fig. 6). Whereas the maximum overpressure level in the 0.5-1.0 psf range is comparable to that in the ascent phase, the contour plot, unlike that in Fig. 5, takes on an onion-ring like pattern with the higher overpressure of 1-3 psf being found mainly on the inner ring. Unlike that in Fig. 5, the zone under 2-3 psf is limited to a transverse dimension of 2-3 nm, which forms the basis (root) of a relatively *narrow column* under water. For this reason, we do not consider the descent phase is more critical aspect of sonic boom problem for the Kodiak plan at the present stage, which certainly deserve attention in a more critical study subsequently.

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